Mechanical World —— December 1958

The Handsome Designer

THE growth of appearance design in recent years stems from the critic, the craftsman and the mass producer. The mass producer has given it a volumetric impetus in striving to add to his products something satisfying to the senses of the user. Often the result does more than this—some kind of "user efficiency" is added which, while not measurable is none the less real to the experienced.

It would be too much to claim that this is altogether new. Where artistic genius has been allied to craftsmanship there have always been things having this quality, whether in their own time or for a longer period. What we have today in appearance design is often satisfying, often experimental or often fashionable. Like popular music most of it attracts—and like popular music a lot of it soon goes stale. To use it sensibly it is therefore important to endeavour to relate appearance design to the expected life of the product. Machinery and plant, for instance, must last for a good many years and in the interests of operating efficiency it must be easy to live with. A factory which is depressing or distracting (two extremes) is not good: one that is stimulating and interesting is beneficial in every way.

During its lifetime the Council of Industrial Design has not given much attention to heavy capital goods because the great output of miscellaneous goods in common use urgently required its attention. Not long ago, however, it did hold a one-day conference on industrial design in heavy engineering and brought together a number of speakers, who showed an undoubted consciousness of the relationship of appearance design to this particular type of product, and who indicated quite clearly that in some quarters at least the technique of discovering and applying appearance design is well developed.

Mr. John Anderson pointed to the embodiment in machinery of good design, precision, high productivity, ease of operation, plus good appearance—"that nebulous something without which the modern designer falls short of the work"—and drew attention to the knowledge of the service engineer—of how the product is used and abused in the customer's plant. The designer should have similar experience: "throw him to the lions", said Mr. Anderson.

A positive approach to developing appearance in machines was given by a German speaker, Mr. Louis Schuler. He is all for design which gives life and character to a machine by visually expressing its technical efficiency. This is a readily understandable idea and one which many competent engineering designers can use—making the machine look its part, not by dressing it up but by building it for all that it can offer—making it almost an organism, and a handsome one at that.

Just how appearance design is enlisted in practice was explained to the conference by Dr. E. W. Seward and Mr. G. S. C. Lucas. The industrial designer is a specialist, either a staff member or a consultant, and he does not work on a job after the drawings have been made; he comes into the picture right at the beginning and more or less follows the work through the design stages, influencing the appearance of the product from its conception to the making of the final plans. There seems to be advantages both in having him on the staff and in engaging an outside man: one knows the particular circumstances and the other is likely to bring fresh ideas. Both methods are used with profit.

At present, appearance design is a specialized function at which not many people excel. To be good at it very likely requires an intimate acquaintance with manufacturing methods and production economy, artistic ability, and an intuitive gift of what is appropriate. In time much of this may be reduced to scientific terms for the great bulk of work, and then it will become a readily usable technique in the drawing office. Even then, there will always be the little extra that only the real artist in the work can provide.

LOG SHEET

Plant Monitoring

Considerable interest was aroused in engineering circles last year when the British Iron and Steel Research Association developed an advanced system of plant performance recording. Originally envisaged as a production aid in the manufacture of steel products, it was at once apparent that the system had many potential uses throughout industry generally.

It is now learnt that one of the licensees, Digital Engineering Company Limited of Battersea, London, has been awarded an extensive contract for monitoring equipment of this type for a big Russian factory project. The apparatus involved will equip some five hundred 'detection points' throughout a giant tyre plant for which the manufacturing machinery and equipment is being built and supplied by a consortium of British firms. Members of the consortium, which is known as Rustyfa Limited, are David Bridge & Co. Limited, Crompton Parkinson Limited, Lancashire Dynamo Holdings Limited, Mather & Platt Limited, Francis Shaw and Co. Limited and Simon Handling Engineers Limited, and the contract to date is valued in the region of £12,500,000. Consultants to the consortium are Dunlop Advisory Service Limited, a direct subsidiary of the Dunlop Rubber Co. Limited and who are responsible for the design and specification of the factory layout, machinery and equipment.

The factory, to be erected near Dneipropetrovsk, is designed for the production of large numbers of tyres for cars, lorries, tractors and heavy earth-moving equipment. Layout and operation will be based on the latest ideas in automation, necessarily involving extensive monitoring.

The entire process of tyre and tube making is to be monitored hourly. Production figures will be obtained for the number of batches of rubber produced by the internal mixers, the number of yards of fabric, the number of extruded treads, or, in the case of giant tyre manufacture, the number of tread parts, the number of uncured and cured tyres and the number of uncured and cured inner tyres.

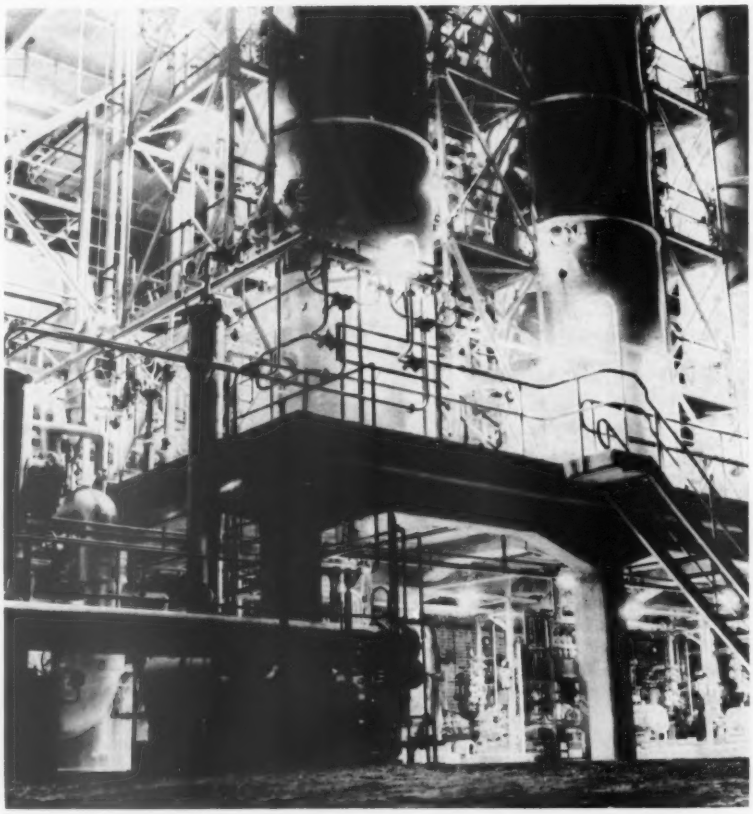
All the counting equipment will be centralized, and an adjacent office will be equipped with page printers where the hourly production totals will appear coded according to size or type. Additional over-riding totals for each shift will also be produced and at these times something like a thousand characters of data will be printed out.

Experience gained in supplying performance recorder units to several British firms led to considerable further development work by the Digital Engineering Company Limited, and the fruits of this are being applied for the Russian project. When the factory comes 'on stream' it should become one of the largest and most advanced tyre plants in the world.

Synthetic Rubber

Synthetic rubber is used in large quantities as an addition to natural rubber, principally because world demand for rubber has increased while the production of natural rubber has not. The principal synthetic rubber made today is GR-S, meaning "Government Rubber Styrene", so named from its being chosen by the United States government for manufacture during the war. It is this kind of rubber which is being made at the new £6,000,000 plant of The International Synthetic Rubber Company Limited at Hythe, on Southampton Water, but there it is called S.B.R., after the names of its main ingredients—styrene and butadiene, which are used in the proportion of one of the former to three of the latter. The butadiene is piped from the nearby Esso refinery at Fawley, and the styrene comes from Forth Chemicals at Grangemouth and from Shell at Partington.

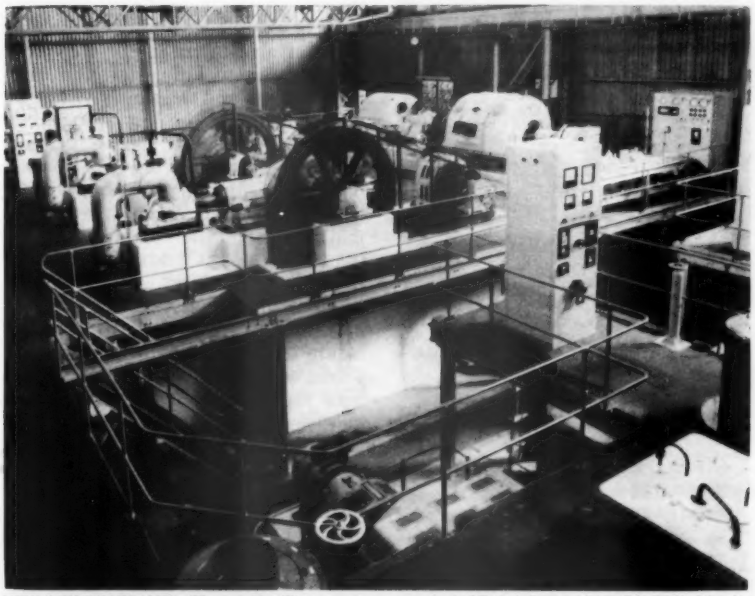
The fundamental process is polymerization of the ingredients and this is done in a continuously operating plant in which there are two trains of reactors in parallel each capable of producing 25,000 tons per year of



The stripping column at the new £6 million synthetic rubber plant which was built in 16 months at Hythe, Hants. The product will be marketed under the trade name of Intol and will be used in the production of a wide range of articles. The greater part of the output will be used by motor car tyre manufacturers

copalymer—equal to about 34,000 tons of rubber. Each reactor is a vertical vessel with internal cooling coils and a central stirrer. Unreacted materials are extracted and the latex coagulated into crumb in water after which it is separated on a rotary vacuum filter, broken down in a disintegrator, dried on conveyors and then baled or packaged.

The equity capital for the plant was subscribed by the U.K. tyre companies who are expected to claim first preference on supplies. The product will be marketed under the brand name Intol.



NEW OXYGEN PLANT.—The new £1 million tonnage oxygen plant of British Oxygen Gases Limited in Lincolnshire is capable of supplying three steel works there with up to two hundred tons of oxygen per day. It is the largest to be fully commissioned in Britain for the supply of oxygen in the quantities now required by steelworks and is the first with a daily capacity of two hundred tons. A similar plant is already in use at Margam, South Wales, and others will be commissioned in South Wales and the North East. A single oxygen producing unit will supply gas to the Appleby-Frodingham Steel Company, Richard Thomas and Baldwins and the Scunthorpe works of John Lysaght Limited. A total of four-and-a-half miles of pipeline is needed to carry the oxygen

Product Development

In recent years there have been many significant advances in the equipment and techniques used in product development, particularly in the field of environmental simulation. Recently the Hymatic Engineering Company Limited of Redditch, Worcestershire has expanded its already well-equipped testing laboratory by the addition of equipment designed further to enhance its capacity for the environmental simulation of its own and others' products.

Components or installations under development can be tested in ambient temperatures of —90°C to +500°C at simulated altitudes of more than 100,000 feet and humidities of 100%.

A climatic test chamber recently installed has been designed and constructed by J. & E. Hall Limited. In a working space of approximately 8 cu ft, the temperature can be controlled within the range —90°C to +70°C with an accuracy of ±1°C. Pressure and humidity can also be accurately controlled. Simultaneous variations of temperature, pressure and humidity can be carried out to simulate the 'breathing' of equipment. Pneumatic and electrical supplies can be fed into the chamber so that equipment can be calibrated and viewed under full operating conditions.

Supporting the climatic test chamber is equipment to enable accelerated testing to be undertaken representing considerable periods of service use in corrosive atmospheres.

Similarly, the determination of whether or not materials in given climatic conditions support fungus growth is an important factor in product development, and equipment has been installed for this purpose as well as for sand and dust testing, which enables the vulnerability of the product to the ingress of dust to be determined in controlled conditions.

These expanded resources form part of a product development laboratory which includes dynamometer test rig equipment, and vibration test equipment, which enables products under development to be tested over a wide range of vibratory conditions experienced in aircraft, vehicles and machinery.

Equipment is also available for measuring and recording transient pressures, temperatures, flows, movements and electrical values, allowing up to four variables to be measured simultaneously. Pneumatic and hydraulic testing equipment, vacuum testing and acceleration testing equipment can all be used in the searching test to which products under development are exposed.

Unified Threads

A recent survey made within the British fasteners industry has shown that the usage of Unified threads for precision bolts and nuts is increasing rapidly. The automobile and petroleum industries and agricultural engineers are all using large quantities, and other industries are changing over gradually.

Twice as many precision bolts and nuts (all grades) and machine screws $\frac{1}{8}$ in. dia and larger are sold with unified threads as with Whitworth or B.S.F. threads and now that the British Standards for Normal Series Unified Black Bolts (B.S.2708 of 1956) has been published there is an increasing demand for unified threads of this type of fastener. For machine screws smaller than $\frac{1}{4}$ in. dia important sections of industry will continue to use the B.A. screw thread but the demand for small machine screws conforming to the American standard and with threads of unified form and pitch is rising and is already about 10% of the total demand.

The unified screw thread has become established as one of the important thread systems in use in Britain. Unified threads have received support in Scandinavia and Holland and at least one Swedish firm has changed from metric threads to unified inch threads; but on the Continent metric threads remain first choice and the metric countries are following the example of America Britain and Canada in unifying their standards, which have hitherto differed from country to country.

During June of this year the Fourth Plenary Session of the International Standards Organization was held in Harrogate and was attended by delegations from 38 countries. This provided an opportunity for further discussions on international screw thread standards and it was agreed to recommend

to the ISO Council that there be two internationally recognized screw thread systems, the unified inch series of threads, the use of which is already widely established wherever the decimal inch is the standard engineering unit of measurement and the newly agreed metric series of pitch diameter combinations which is to be adopted by metric countries though as yet it exists only on paper.

A feature of the screw thread discussions was the wealth of evidence submitted by the American and Canadian Delegations to show that in both countries unified screw threads have completely superseded the older American National Coarse and American National Fine series. Industries seeking sales in North America will certainly benefit if they adopt unified threads in any equipment they may have to offer.

First Traction Silicon Rectifier

The first silicon power rectifier to be used to convert electric power for traction service in Great Britain has been installed experimentally in a motor-coach on the Lancaster/Morecambe/Heysham line of British Railways (London Midland Region). Although this line is in public service it has, since its re-equipment on the 50-cycle system been used by the B.T.C. as a testing ground for a.c. 50-cycle traction equipment. The installation of this rectifier, made by British Thomson-Houston, represents a further pioneering step by British Railways.

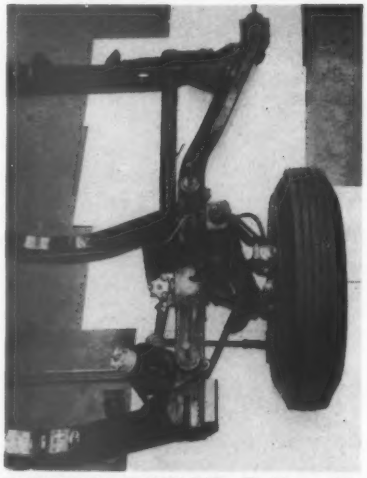
The coach has been operating successfully since December 1955 with an equipment using germanium cells, also of BTH manufacture, and this has now been removed in order to accommodate the silicon equipment consisting of cells of the latest type.

Whereas the original equipment comprised 600 germanium cells, the new rectifier embodies only 192 silicon cells of comparable unit size. This represents a substantial saving in size and weight. Moreover, the silicon cell can operate without danger at a considerably higher temperature than is permissible with a germanium cell.

Silicon power cells are being produced at a new plant in the BTH Rugby Works where germanium power cells are now in mass-production. Increasing use is being made of Rugby-made semi-conductor rectifiers not only in traction but for numerous industrial applications.

Incorporated Plant Engineers

The headquarters of Incorporated Plant Engineers has been moved to London from the Midlands and is now at 2 Grosvenor Gardens SW1. The institution had its origins in the second world war when the engineers in charge of the large American excavators imported for working open-cast coal, met together for the exchange of information and mutual



LAMINATED TORSION BAR.—The history of the laminated torsion bar made by Geo. Salter & Co. Limited and used in the new 3-litre Rover car goes back 20 years to when Mr. John Bache, now technical director of Salters, began experiments with the system on an old Star chassis. Since then the system has been proved under exacting conditions in various racing cars

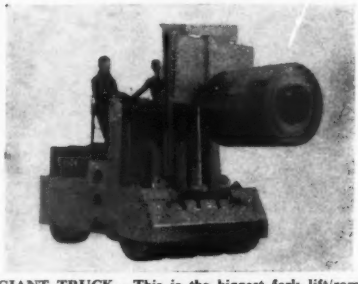
help. The meetings proved so beneficial that the engineers concerned decided to continue them through the medium of an institution and the Memorandum of Association of Incorporated Plant Engineers was signed on September 3, 1946.

Its aims attracted engineers in many fields and within a year there were branches in London, Birmingham, Manchester, Leeds, Newcastle, Glasgow, and Bristol. The following year saw a further six branches established and by 1954 there were 18 in the United Kingdom and one (Bombay) overseas. Membership which at the end of 1946 was 120, is now nearly 4,000 of whom more than 500 are overseas spread through most countries of the world.

The institution defines the professional plant engineer as: "... one who, by virtue of the combination of his education, training and experience, is able to assume personal responsibility for the development and application of engineering science and knowledge in research, development, specification, design, construction, manufacture, management, and the education of other Plant Engineers".

The Institution recognizes that the term 'Plant Engineer' covers a wide range of people and functions and has framed its membership requirements so that applicants with modest academic qualifications are not necessarily excluded. It believes that there are many such men who over the years have amassed a considerable store of experience and expertise and are thus able to make an invaluable contribution to industrial efficiency.

Education and training have been a main concern of the Institution from its inception and the Education Committee (in February 1947) was one of the first to be appointed by the council. This committee took a major part in the establishment of the City and Guilds of London Institute's Certificate in Plant Engineering (Course 187). Its other main activity has been the organization of refresher courses for senior works and plant engineers which are held each winter at university level in various industrial centres.



GIANT TRUCK.—This is the biggest fork lift/ram truck in Australia and is in service at Lysaghts C.R.M. Works at Port Kembla. Capable of lifting, transporting and stacking a 25,000 lb load, measuring 5 ft long, the truck is being used to handle coils of steel strip and steel plate between the various processes in the plant. It is equipped for both ram and fork operation. Built by Yale & Towne Manufacturing Company, of Philadelphia, U.S.A., it is powered by a battery weighing 3½ tons manufactured by Chloride Batteries Limited, Clifton Junction, Manchester

Off-the-job Safety

The Du Pont organization in the United States employs some 90,000 people and has a very creditable safety record in comparison with U.S. industry generally. A recent analysis by the company's safety officers shows that Du Pont employees suffer fewer accidents away from work than do the U.S. population as a whole. This has resulted from an off-the-job safety

programme over the last five years during which time injuries away from work have declined by 25%.

Enclosed Spray Booth

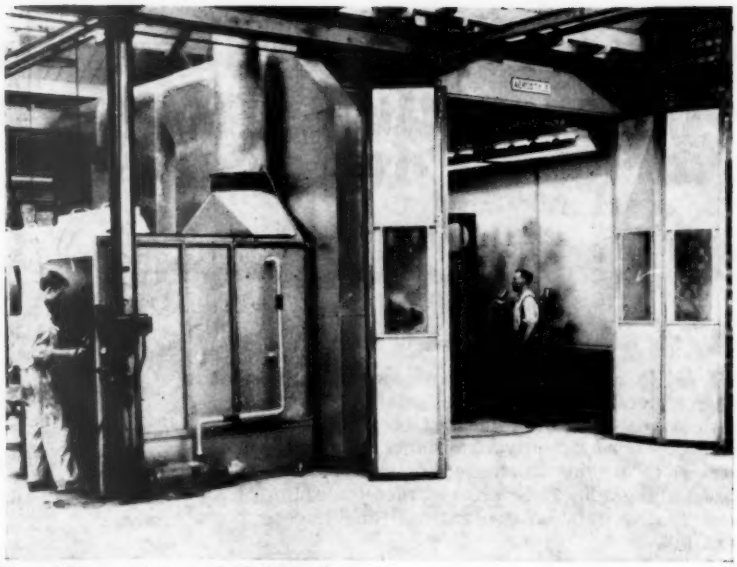
Maintaining the quality finish of the various items of instruments, controls and instrument panels manufactured by Electroflo Meters Company Limited, has been an important production factor in keeping with the high standard of their complicated equipment. Component parts of the assemblies can be of so many different sizes that unification of the finishing processes has not been easy. With large surfaces to cover with enamels and large areas utilized for ease of movement from forming to finishing areas, within the factory, one of the greatest difficulties has been the problem of dust particles.

When an extension to the busy factory in Park Royal was considered, Electroflo Meters Company Limited approached their neighbour, Aerostyle Limited, with their unwieldy problem of equipment in diverse shapes and sizes, bearing in mind the cost of this stage of production and the economic utilization of space.

The normal open-front water wash booth was not suitable for all purposes and to provide a clean workshop atmosphere, both for operator comfort and to maintain quality, a totally enclosed custom-built spraying shop was constructed mainly for the purpose of spraying large instrument panels and cubicles. The booth, 22 ft long × 11 ft 9 in. high, was developed in co-operation with Electroflo Meters Company Limited, for this particular purpose within this factory extension. Main considerations governing the design were the filtering of incoming air and because the operations were to be "sealed" inside, a safe, efficient exhaust system had to be incorporated.

The entire prefabricated shop is built of galvanized sheeting with the induction through special metallic filters above the enclosed spray paint-shop, on each side, cleaning the air drawn from the factory at a normal temperature for operator comfort and paint application.

Air outlets are arranged through four dry exhaust filters, easily and cheaply replaced or refilled, placed at the base of the two longitudinal walls passing virtually clean air up through the external ducts through



The specially constructed spray booth showing, from left to right, water wash booth for smaller pieces of equipment individually ducted, open rubber sealed doors (closed when in use) and proportionate size to equipment and operator, and on right of interior, exhaust filters at base of wall

four fans, situated above the room itself, each having a separate push-button starter so that should the total area not be used for larger units of equipment then it is only required to use the appropriate necessary exhaust, say, one or two fans.

Stressed, steel, rubber-sealed folding doors prevent the ingress of dusty air but the atmosphere within the spraying shop with doors closed is very comfortable with little noise except for the steady purr of the exhausts which seems to harmonize with the hiss of the spray guns with no acoustic disadvantages or operator strain. Herein, spray painted sections may be left for surface drying with clean air circulating without risk of damage by dust.

However, for the many smaller pieces of equipment, a 5 ft open-fronted water wash booth was fitted to the outside of the spray paint shop with its own built-in exhaust ducted through the main exhaust system. This simple positioning has its own advantages as the 6 ft 6 in. projection leaves that width along the side of the spray shop for a mobile arrangement of paint storage.

This installation just completed is already proving successful as the area taken up by the large booth is justified by ease of movement, dust-free pleasant working conditions within, leading to higher productivity. The water wash booth, by simple and careful arrangement, ensures that this particular floor area is best used leaving the total area free for all movements of all equipment from construction to spray finishing and on the assembly.

Clocks to Cocks—125 Years of Brassfounding

One hundred and twenty five years in the present business and over 200 years in brass founding is the proud record of Robert Harlow and Son Limited, Stockport, Cheshire, makers of valves, cocks and brass fittings who continue to be a very active family concern today.

Robert Harlow founded a business in Stockport in 1833 to manufacture clock parts and a wide range of cocks and fittings for use with steam, gas, water and spirits—in ... former craft he was well ... for he hailed from a family of Derbyshire clockmakers with businesses in Ashbourne and Birmingham. Moving into the present premises in 1855 he continued to give increasing attention to the development and production of valves and fittings to meet the rapid growth of local manufactories, a direct contrast to the clock-making interests which by this time had almost disappeared.

Since the death of the founder in 1878 the business has been steadily expanded by successive generations of the Harlow family until today the firm has over 3000 products listed in its new catalogue of valves and fittings.

Comparative Data on the Total Cost of Generation of Conventional and Nuclear Power Stations

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

WHEN considering new power station projects it is imperative to prepare a detailed analysis of the various costs. As the total cost of generation per unit sent out is of primary importance, it is proposed to present as a guide to engineers a number of formulae, tables and graphs and typical worked-out examples with comparative data on conventional and nuclear power stations.

The total cost of generation consists of the capital charges, the fuel charges and the operation and maintenance costs. For nuclear station one has to add the fuel inventory charges.

A. The annual capital charges

The total annual capital charges (R) for the complete station is the summation of

(a) depreciation (R_1)

(b) interest on the capital (R_2)

which are expressed by the following well established formulae

$$R_1 = C(p-1)/(p^n-1)$$

$$R_2 = C(p-1)$$

$$R = R_1 + R_2 = C\left[\frac{p-1}{p^n-1} + (p-1)\right]$$

$$C/R = (1/p^n)\,(p^n-1)/(p-1)$$

$$R/C = [p^n(p-1)/(p^n-1)] \times 100\,\%$$

where

C = initial capital expenditure for the complete station.
R = yearly payment of the depreciation and the interest on the capital at the end of the year.
n = number of years of payment.
p = 1+k/100
k = rate of interest in %

The value for the ratio C/R and the percentage of R/C for rates of interest from 2 to 8% up to 25 years can be obtained from Table I and Fig. 1.

For example, using Table I we find

(a) k=6% n=25 years
C/R=12·783 (col.8)
R/C=7·823% (col.9)

Table I.—TOTAL ANNUAL CAPITAL CHARGES

$$C/R = \frac{1}{p^n}\left[\frac{p^n-1}{p-1}\right]$$

$$R/C = p^n\left[\frac{p-1}{p^n-1}\right] \times 100\,\%$$

C = Initial capital, £
R = Yearly payment, £, of interest on depreciation and on capital at the end of the year.
p = 1+k/100
k = Rate of interest, %
n = Number of years of payment

1	2	3	4	5	6	7	8	9	10	11	12	13
Years	RATE OF INTEREST											
	3%		4%		5%		6%		7%		8%	
	C/R	R/C%	C/R	R/C%	C/R	R/C%	C/R	R/C%	C/R	R/C%	C/R	R/C%
2	1·913	52·28	1·886	53·02	1·859	53·79	1·833	54·55	1·808	55·33	1·783	56·08
3	2·829	35·35	2·775	36·03	2·723	36·72	2·673	37·41	2·624	38·11	2·577	38·80
4	3·717	26·90	3·630	27·55	3·546	28·20	3·465	28·86	3·387	29·53	3·312	30·19
5	4·578	21·84	4·452	22·46	4·329	23·10	4·212	23·74	4·100	24·39	3·993	25·04
6	5·417	18·46	5·242	19·07	5·076	19·70	4·917	20·34	4·767	20·98	4·623	21·64
7	6·230	16·05	6·002	16·66	5·786	17·28	5·582	17·91	5·389	18·56	5·206	19·21
8	7·020	14·25	6·733	14·85	6·463	15·47	6·210	16·10	5·971	16·75	5·747	17·40
9	7·786	12·84	7·435	13·45	7·108	14·06	6·802	14·71	6·515	15·35	6·247	16·01
10	8·530	11·72	8·111	12·33	7·722	12·95	7·360	13·59	7·024	14·24	6·710	14·90
11	9·253	10·81	8·760	11·42	8·306	12·04	7·887	12·68	7·499	13·33	7·139	14·01
12	9·954	10·05	9·385	10·55	8·863	11·29	8·384	11·92	7·943	12·59	7·536	13·27
13	10·635	9·403	9·986	10·01	9·394	10·65	8·853	11·30	8·358	11·97	7·904	12·65
14	11·296	8·853	10·563	9·467	9·899	10·10	9·295	10·75	8·745	11·43	8·244	12·13
15	11·938	8·377	11·118	8·994	10·380	9·634	9·712	10·30	9·108	10·98	8·559	11·68
16	12·561	7·961	11·652	8·582	10·838	9·227	10·106	9·895	9·447	10·56	8·851	11·30
17	13·166	7·595	12·166	8·220	11·274	8·870	10·477	9·545	9·763	10·25	9·122	10·96
18	13·753	7·271	12·659	7·899	11·690	8·554	10·828	9·235	10·089	9·941	9·372	10·67
19	14·324	6·981	13·144	7·608	12·085	8·275	11·158	8·962	10·336	9·675	9·604	10·42
20	14·877	6·722	13·590	7·358	12·462	8·024	11·470	8·718	10·594	9·439	9·818	10·18
21	15·415	6·487	14·029	7·129	12·821	7·800	11·764	8·501	10·836	9·228	10·017	9·983
22	15·937	6·275	14·451	6·920	13·163	7·597	12·042	8·304	11·061	9·041	10·201	9·803
23	16·444	6·081	14·857	6·731	13·489	7·414	12·303	8·128	11·272	8·872	10·371	9·642
24	16·936	5·891	15·247	6·559	13·799	7·247	12·552	7·967	11·469	8·719	10·529	9·498
25	17·413	5·743	15·622	6·401	14·094	7·095	12·783	7·823	11·654	8·581	10·675	9·368

(b) k=6% n=20 years
C/R=11·47 (col.8)
R/C=8·178% (col.9)

B. Cost of power generation for a modern coal burning steam station

1. Assumptions

(a)	Installed capacity	250 MW
(b)	Capital cost per kW installed	£50
(c)	Fuel cost per ton of coal	90 shillings
(d)	Calorific value of coal	10,000 B.t.u/lb
(e)	Net overall thermal efficiency	35%
(f)	Rate of interest	6%
(g)	Life of plant	25 years
(h)	Load factor	80%

2. Capital cost of plant
250,000×£50 — £12,500,000

3. Heat consumption
3412/0·35 — 9750 B.t.u/kW-hr

4. Coal consumption
9750/10,000 — 0·975 lb/kW-hr

5. Units sent out per annum
250,000×8760×0·8 — 1,752 million kW-hr

6. Fuel cost per unit sent out in pence
0·975×90×12/2240 — 0·470 pence/kW-hr

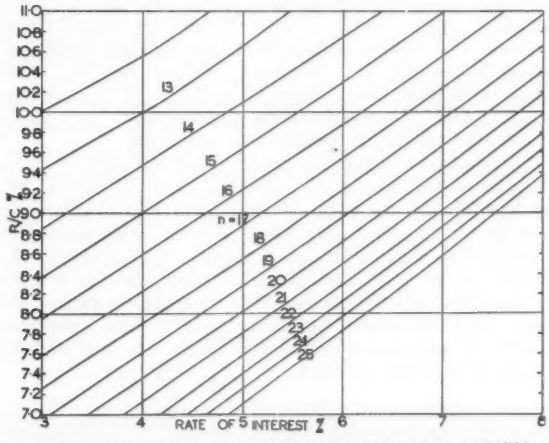


Fig. 1.—Ratio of depreciation to capital for various rates of interest. $R/C\% = \left[p^n(p-1)/(p^n-1)\right] \times 100$; C = initial capital cost, £; R = yearly payment in £ of interest on depreciation and on capital at the end of the year; p = 1 + k/100; k = rate of interest, %; n = number of years of repayment

7. Ratio of capital cost to annual charges at 6% and 25 years

$$\frac{C}{R} = \frac{p^n - 1}{p^n(p-1)} \qquad 12{\cdot}783$$

C = capital cost of plant
R = annual charges for plant

$$p = 1 + \frac{\text{Interest \%}}{100} = 1{\cdot}06$$

n = number of years for annual payment = 25

8. Annual charges in % of capital cost
(1/12·783) ×100 — 7·825%

9. Annual capital charge in £
12,500,000×0·07825 — £978,125

10. Annual capital charge in pence per kW-hr
978,125×240/1,752,000 — 0·134 pence/kW-hr

11. Operation and maintenance cost
0·05 pence/kW-hr

12. Total generation cost per kW-hr sent out
0·6541 pence/kW-hr

13. Summary of costs per kW-hr sent out

		Pence/kW-hr	%
(a)	Capital charge	0·134	20·48
(b)	Fuel charge	0·470	71·87
(c)	Operation and maintenance	0·050	7·65
(d)	Total costs (a)+(b)+(c)	0·654	100·00

C. The economics of nuclear power stations in 1963-65

Cost of power generation from a gas-cooled graphite-moderated reactor having an electrical output of 250 MW.

1. Assumptions

(a)	Capital cost (excluding fuel) per kW M.C. rating (electrical)	£120/kW
(b)	Fuel charge per MW electrical	1·4 tons/MW
(c)	Level of irradiation	3000 MWD/ton
(d)	Fuel cost	£15,000/ton
(e)	Life of plant	20 years
(f)	Rate of interest	6%
(g)	Thermal efficiency	25%
(h)	Load factor	80%

2. Total capital cost of plant (excluding fuel)
250,000 kW×(1a)
=250,000×120 — £30,000,000

3. Fuel charge required
250MW×(1b)=250×1·4 — 350 ton

4. Capital cost of fuel
(3)×(1d)=350×15,000 — £5,250,000

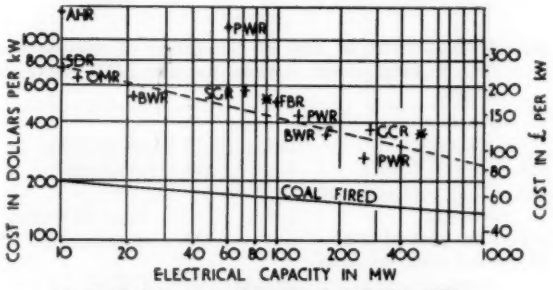


Fig. 2.—Capital cost of nuclear power plant (October, 1957)
Type of Reactor
AHR, Aqueous Homogeneous
SDR, Sodium Deuterium
OMR, Organic Moderated
BWR, Boiling Water
PWR, Pressurized Water
FBR, Fast Breeder
SGR, Sodium Graphite
GCR, Gas Cooled
+America. *Great Britain (gas-cooled graphite moderated reactor)

5. Ratio of capital cost to annual fixed charges at 6% interest for 20 years

$$\frac{C}{R} = \frac{p^n - 1}{p^n(p-1)} \qquad 11{\cdot}47$$

where

C = total capital cost of plant
R = annual fixed charges

$$p = 1 + \frac{\text{annual interest \%}}{100} = 1{\cdot}06$$

n = number of years = 20

6. Annual fixed charge for capital cost of plant

(2)/(5) = £30,000,000/11·47 £2,615,000

7. Interest on cost of fuel per annum at 6%

(4) × 0·06 = £5,250,000 × 0·06 £315,000

8. Total charge per annum

(6) + (7) £2,930,000

9. Heat output required from the reactor

250 MW (Electrical)/(Thermal Efficiency) = 250/0·25 1000 MW

10. Annual fuel replacement cost

$$(9) \times \frac{(1h)}{100} \times \frac{(1d)}{(1c)} \times 365 \text{ (days)}$$

$$= \frac{1000 \times 0{\cdot}8 \times £15{,}000 \times 365(\text{days})}{3000} \quad £1{,}460{,}000$$

11. Number of kW-hr sent out per annum at a load factor of 80%

8760 × 0·8 × 250,000 1,752 million kW-hr

12. Cost of generation in pence per kW-hr

	Pence/kW-hr
(a) Depreciation and interest on plant (6) × 240 (pence)/(11) = 2,615,000 × 240/1,752,000,000	0·3586
(b) Interest on fuel charges (7) × 240 (pence)/(11) = 315,000 × 240/1,752,000,000	0·0432
(c) Fuel replacement charge (10) × 240 (pence)/(11) = 1,460,000 × 240/1,752,000	0·2003
(d) Operation and maintenance	0·0500

13. Total generation costs in pence per kW-hr

(12a) + (12b) + (12c) + (12d) 0·6521

D. A comparison of cost of generation of nuclear and coal burning power stations for 250 MW electrical output

1. Assumption

Station	Nuclear	Coal burning	
(a) Capital cost	120	50	£/kW(Elec)
(b) Fuel charge of uranium	1·4	—	Tons/MW(Elec)
(c) Fuel cost of coal	—	90	shillings/ton
(d) Fuel cost of uranium	15,000	—	£/Ton
(e) Level of irradiation	3000	—	MWD/Ton
(f) Calorific value of coal	—	10,000	B.t.u/lb
(g) Net overall thermal efficiency	25	35	%
(h) Load factor	80	80	%
(i) Life of plant	20	25	years
(j) Rate of interest	6	6	%

2. Costs in pence per unit

(a) Capital charges	0·3586	0·134
(b) Interest on fuel charge	0·0432	—
(c) Fuel replacement charge	0·2003	—
(d) Fuel charge for coal	—	0·470
(e) Operation and maintenance	0·0500	0·050
(f) Total generation cost	0·6521	0·654

3. Cost in per cent of total generation costs

(a) Capital charges	54·99	20·48
(b) Interest on fuel charges	6·62	—
(c) Fuel replacement charge	30·72	—
(d) Fuel charge for coal	—	71·87
(e) Operation and maintenance	7·67	7·65
	100·00	100·00

E. Capital costs of nuclear power stations in America and Great Britain (1957)

These figures are presented graphically in relation to the electrical capacity in MW in Fig. 2.

Dual Control 6-ton Dumper

Two-way driving controls reducing turn round time on any job is a major feature of the Chaseside High-speed, Model D.5, medium-sized dumper announced by the Chaseside Engineering Company Limited of Hertford. It has a 13,500 lb payload, and is powered by a four-cylinder Fordson diesel engine which develops 61·5 bhp at 2250 rpm. Servo-assisted brakes are fitted to all wheels. The hopper with an extra large and low "spotting" area for quick and accurate loading can be raised hydraulically to its full tipping angle of 70° in less than six seconds. The hopper floats automatically back to the carrying position as the dumper moves off.

The engine power is transmitted through a large torque capacity clutch, constant mesh gearbox and independently mounted transfer box which duplicates the speeds in either direction to a heavy duty two-speed differential axle (with vacuum operated change). This arrangement gives ten forward speeds and ten reverse.

Excellent visibility is available from the operator's cab and great attention has been paid to the operator's comfort. The dual controls are ideally planned and the steering is power assisted.

Chaseside D.5 Hi-speed dumper with dual steering and controls

Construction and Operation of Saturable Reactors

Saturable reactors provide an economical means of reducing the voltage applied to an a.c. load circuit and may be used for such purposes as control and protective systems, d.c. current and voltage transformers, voltage regulators, firing control of mercury-arc rectifiers. They are incorporated in magnetic amplifiers for servo systems, digital computers, battery chargers, motor speed control systems, dimming of theatre lights, etc. This article describes the construction and operation of various non-feedback saturable reactors

A SERIES inductor provides a means whereby the load current obtained from a source of alternating voltage can be controlled. The volt drop (V_d) across the inductor is equal to the product of the load current (I amps) and the impedance (Z ohms) of the inductor. The impedance is usually very largely due to inductive reactance (X ohms). If the load current has a sinusoidal wave form, and the flux density in the inductor core is proportional to the current, X is equal to $6{\cdot}284 \times f \times L$ ohms, where f is the frequency of the supply, and L the self-inductance of the winding in henrys. L is proportional to the change of magnetic core flux produced by a small change of load current, and to the number of series turns in the inductor winding.

A saturable reactor is an adjustable inductor in which the impedance can be varied by applying a control magnetomotive force (M.M.F.) to the core. The control M.M.F. is produced by passing current through a control winding, or windings, on the core, the M.M.F. being proportional to the product of the control current and the number of turns through which it is passed. In its simplest form a saturable reactor thus has an a.c. winding in series with the load circuit and a d.c. winding for the control current. The core flux produced at any instant depends on the M.M.F. of the two windings, and thus on the current in the windings at that instant. The reactor may be used to control the current in a circuit, such as a lighting circuit, fed from an a.c. supply of any virtual voltage. More complex reactors may also be controlled by bias and feedback windings. Saturable reactors may also be used with metal or valve rectifiers in a magnetic amplifier for the amplification, control or measurement of electrical quantities.

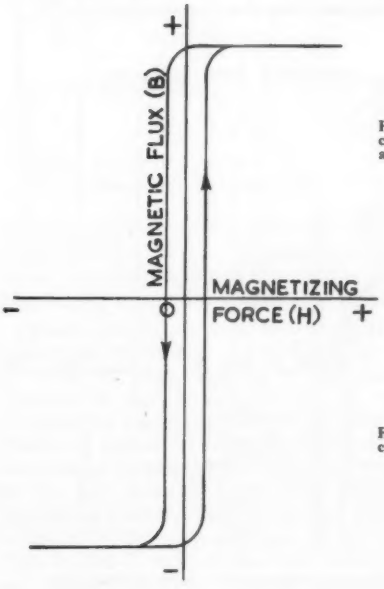


Fig. 1 (left).—Magnetizing curve for a core metal having a rectangular hysteresis loop

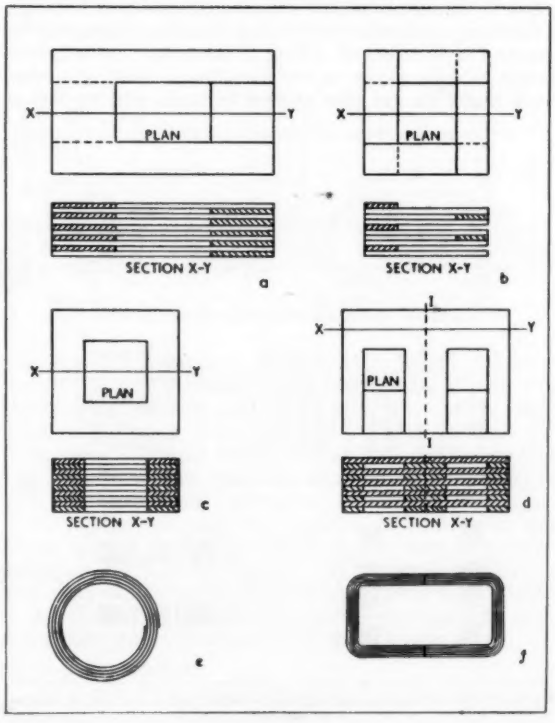


Fig. 2 (right).—Types of cores used for single-phase saturable reactors

Core materials

For maximum impedance with a given a.c. winding and a given core area the windings should be fitted on a core of high permeability, so that a comparatively high magnetic flux density is produced in the core per amp a.c. when the control current has minimum value. The permeability of the core material is equal to Magnetic

flux density (B)/Magnetizing force (H), where H is equal to the M.M.F. per unit length of the magnetic circuit of the core. So that a large amount of power may be controlled with a given weight of core material it is also desirable that the core should be able to carry a considerable flux density without becoming saturated. In the case of a core metal having a rectangular hysteresis loop, as in Fig. 1, maximum permeability occurs with almost the maximum (saturation) flux density, which condition allows a high power-handling capacity for a given weight of core. Efficiency demands that the core plate material should have minimum hysteresis and eddy-current losses, which are limited by selection of core plate material and using very thin core plates.

The magnetic characteristics of core materials may determine the type of core construction to be employed for certain purposes. The common ferromagnetic materials, such as iron, nickel, cobalt, and alloys of these materials, have crystalline structures which have certain directions in which magnetism can be produced more easily than in other directions. For instance there are six directions of easy magnetization of pure iron, these lying along the edges of the cubic crystals. In some materials the ratio of maximum permeabilities of the easy and hard directions of magnetization may be quite high. The magnetic properties of some materials may be considerably affected by grain orientation, internal and external mechanical strains, and the presence of impurities, which depend on the composition of the metal and the manufacturing processes.

There are four directions of easy magnetization in grain-orientated nickel-iron alloys such as HCR metal, Deltamax, Permalloy F, Orthonik, etc., these directions being mutually at right angles along the edges of the cubic crystals. Such materials are particularly suitable for cores built from rectangular stampings as in Figs. 2a, b, c and d. Grain-orientated silicon-irons, such as Hipersil, Crystalloy, Alphasil, have an easy direction of magnetization in the direction of rolling of the metal, but magnetization at right angles to this direction is much less easy. Such materials are best utilized in cores constructed of strips, as in Figs. 2e and 2f. Similar remarks apply to grain-orientated nickel-iron alloys which have also been domain-orientated by suitable treatment.

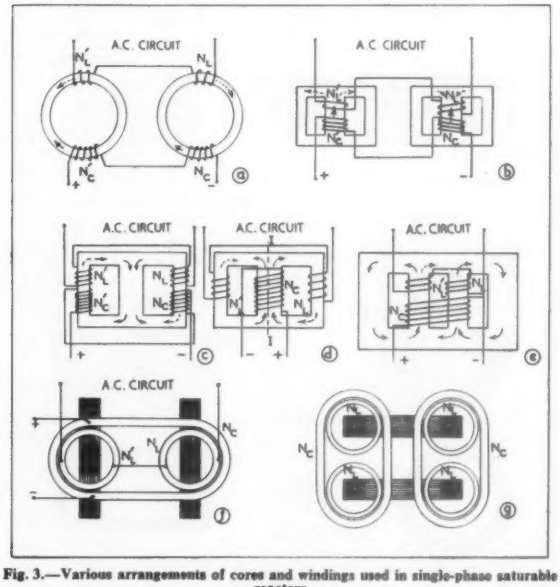


Fig. 3.—Various arrangements of cores and windings used in single-phase saturable reactors

Core constructions

The operating characteristics of a saturable reactor largely depend on the shape of the B/H curve, where B is the flux density and H the magnetizing force (M.M.F. per unit length of magnetic circuit), and on the point at which the reactor is operating on this curve. With ordinary butt joints the cross sectional area of the actual metal path of the flux is reduced at the joints, so that saturation occurs at these points at a lower flux than at other points in the core. This gives a double bend or "knee" in the B/H magnetizing curve, and increases the leakage flux. However, small air gaps in the core may be permissible if a wide range of linear operating characteristics is not required.

For other purposes, where linear operating characteristics are required, air gaps should be avoided. One type of core is constructed, as in Fig. 2a, with U-shaped laminations which are overlapped over a considerable part of the magnetic path. The base of the U, where overlapping does not occur, is wider than the sides so that the cross sectional area of the core is constant. A similar scheme using E-shaped laminations

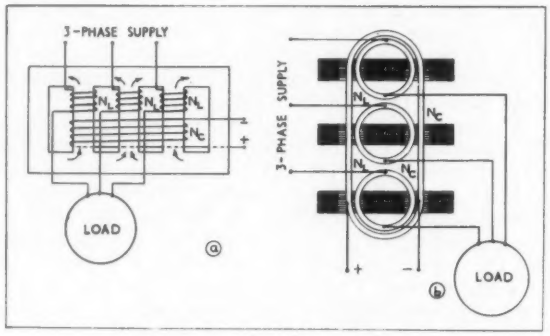


Fig. 4.—Two types of three-phase saturable reactors

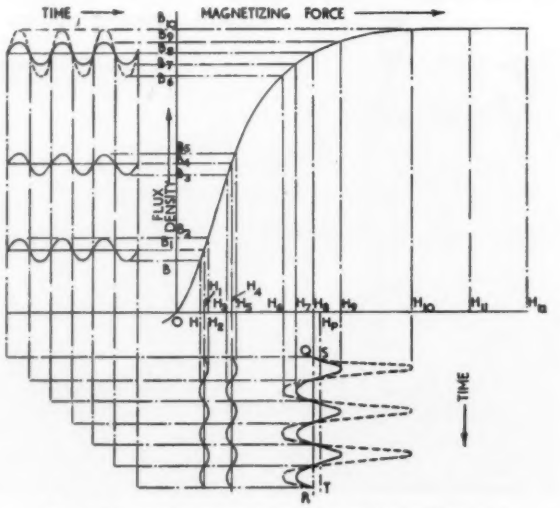


Fig. 5.—Effect of altering control current of a simple saturable reactor

is shown in Fig. 2d. Butt joints may also be eliminated by using one-piece laminations as in Fig. 2c, with special methods for winding the coils. Special coil winding methods are also necessary with the wound-strip core of grain-orientated silicon-iron shown in Fig. 2e. Such material may also be used with ordinary coils in the core shown in Fig. 2f, which has two C-shaped portions of wound strip. The wound strip is insulated and the core then cut in two, the cut surfaces being ground and etched and rigidly clamped, after fitting the coils, to ensure a very small and consistent air gap at each point of cutting.

Winding arrangements

The various windings on a saturable reactor are normally arranged so that magnetic leakage is reduced to a minimum, and one coil may be wound over the other. The alternating load current creates an alternating M.M.F. and, if this creates alternating magnetism which is linked with the d.c. control, bias, or feedback windings, undesirable voltages of supply frequency may be induced in these windings. If the induced voltage causes an induced alternating component current in the control windings the operation of the reactor may be adversely affected. One method of limiting such induced currents is by connecting a high resistance in the control circuit, but this necessitates an increase of control voltage for a given control current, and thus reduces the power gain. The method may, however, be practicable in a very sensitive magnetic amplifier using external or internal feedback in which the ratio of control winding turns to load winding turns may be of the order of 1 to 10.

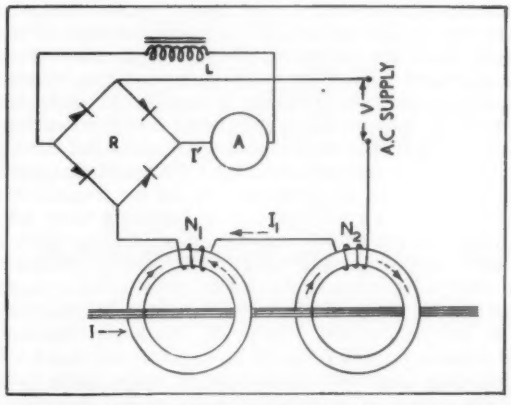


Fig. 6.—Series-connected saturable reactors in a d.c. measuring circuit

Another method of limiting induced currents in the control circuit is by connecting an inductor in this circuit, but this increases the time taken for a magnetic amplifier to respond to a change of applied control volts.

Other methods aim at reducing the overall induced voltage in the control circuit by special arrangement of the coils. In Figs. 3a, 3b, 3c, 3e and 4a the control windings N_c may be wound over the load windings N_L to minimize magnetic leakage, although they have been shown as separated coils for simplicity. The magnetic flux created by the controlling direct current is indicated by the full arrowed lines, whilst that created by the alternating load current during one half of each cycle is indicated by the dotted arrows. Whilst the a.c. fluxes in Figs. 3a and 3b may induce high voltages in the control coils N_c and N'_c if the ratio of control coil turns to load coil turns N_L and N'_L is high, the induced voltages in the d.c. coils N_c and N'_c are in opposition. Thus the induced voltages cancel out and are electrically neutralized as far as the terminals of the control circuit are concerned, and do not affect the value of the control current. This arrangement has the disadvantage that a high degree of insulation is necessary on the control coils, but it can be used satisfactorily in a magnetic amplifier feedback circuit having a relatively small number of control coil turns. With the arrangements shown in Figs. 3a and 3b all the core material is active. A similar system of electrical neutralization is adopted with the arrangement shown in Fig. 3c, in which the centre limb of the core is used only for the d.c. control flux. It will be realized that in all these arrangements there will be zero d.c. flux with zero control current, under which conditions a given alternating load current will create maximum flux and the reactor will have maximum impedance. With a sufficiently high control current the core can be saturated so that the load current will be able to produce no a.c. flux; the reactor will then have minimum impedance and there will be no induced voltage in the control coils.

With the core shown in Fig. 3d the centre limb carries only the d.c. control flux; the a.c. flux due to the load current is not linked with the control coil so that the transformer effect is neutralized magnetically so far as

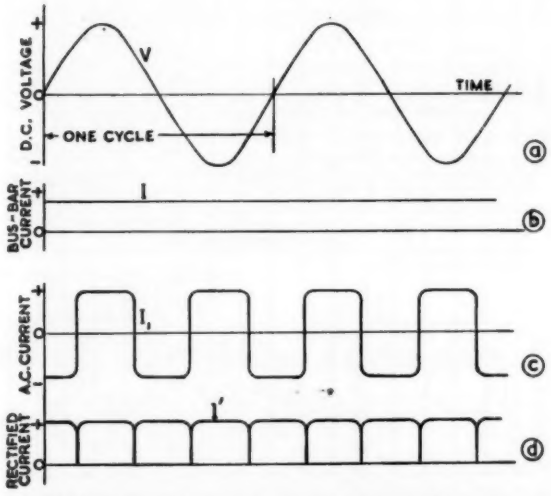


Fig. 7.—Voltage and currents in a saturable reactor measuring circuit

voltages of fundamental or supply frequency are concerned. Magnetic neutralization also occurs with the arrangement shown in Fig. 3e, the d.c. flux passing through the outer limbs and the a.c. flux through the inner limbs. Thus the net a.c. flux linked with the control coil turns N_c is zero. Magnetic neutralization also occurs with the double-core arrangement shown in Fig. 3f, in which all the core material is active. In some cases the centre limb of the core shown in Fig. 3d may be split as indicated by the dotted line I-I to avoid disturbing hysteresis effects resulting from there being no a.c. flux in this limb. Fig. 3g shows a toroidal arrangement with a common d.c. control coil linking both tape cores.

Three-phase reactors

The five-limbed core shown in Fig. 4a is suitable for a three-phase saturable reactor with the outer limbs acting

as a return path for the d.c. control flux; there being magnetic neutralization of transformer effect with respect to voltages of supply frequency. Magnetic neutralization also obtains with the arrangement shown in Fig. 4b, which has a shell-type core. However, since each phase operates on one of the half cycles of the a.c. supply only, these two types of reactors allow second harmonic currents to be introduced into the a.c. circuit.

Effect of varying the control current

The effects obtained with a saturable reactor are influenced considerably by the shape of the B/H curve for the core which, as explained previously, may be affected by the presence of air gaps in the core. Fig. 5 indicates the effects which may be obtained with a simple

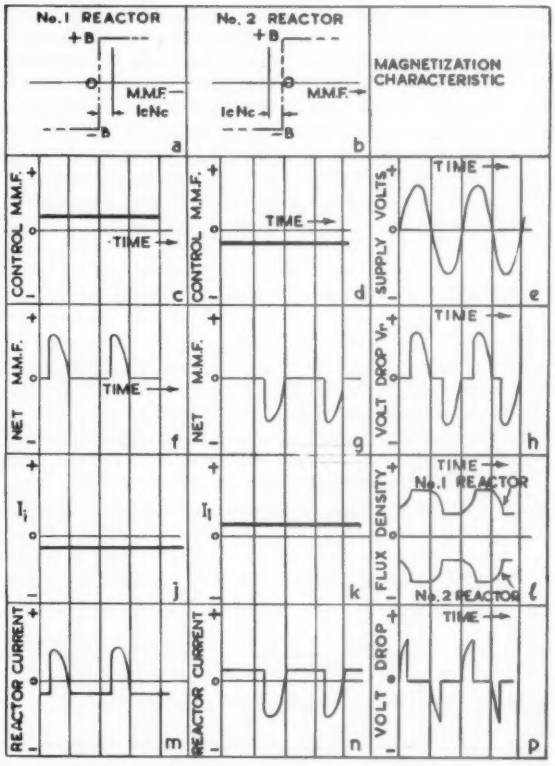


Fig. 8.—Operating conditions in a two-core parallel-connected single-phase saturable reactor

saturable reactor having little air-gap effect, assuming that the control current is unaffected by induction from the load windings. The core is assumed to be subject to a control magnetizing force due to current in the control windings, and an alternating magnetizing force due to the a.c. in the load windings. It will be noted that if the core is subject to a control magnetizing force O-H_1, created by a comparatively small control current, a comparatively small alternating magnetizing force H-H_2, due to a comparatively small load current, will cause the flux density to alternate between the values O-B and O-B_2. If the control current is increased to give the control magnetizing force O-H_4 a similar small alternating magnetizing force H_3-H_4 will create a corresponding change B_3-B_4 in the flux density. This is because the core is still operating on the same linear portion of the B/H curve. Since a relatively small change of magnetizing force H is required to create a comparatively large change of flux density B, the incremental permeability of the core is relatively high, as is also the change of flux density per amp change of current. Under these conditions the reactor has a high inductance so that a high alternating volt drop is produced per amp alternating load current, giving minimum load current. Whilst operating on the linear portion of the magnetization curve a sinusoidal load current will be passed through the reactor with a sinusoidal supply voltage, provided there are no distorting effects in the external load circuit.

However, if the control current is increased to give the control magnetizing force O-H_8 and the flux density O-B_8, a similar change of flux density B_7-B_9 requires a greater change of alternating magnetizing force H_7-H_9. Due to the reactor now operating at the knee of the magnetization curve the change of flux per amp change of current is reduced, giving a reduced operating permeability. The reactor then has a reduced inductance and a reduced a.c. volt drop per a.c. amp. Thus, by increasing the control current, the load current passed through the load circuit due to a given a.c. voltage is reduced. It will be noted, however, that the magnetizing force required to produce a sinusoidal change of flux density is no longer sinusoidal. This is due to the reactor operating at a point where the slope of the B/H curve, and the core permeability, are not the same at the crests and peaks of the flux wave. At such a point the wave form of the current in a circuit of constant impedance fed through the reactor from a sinusoidal source of a.c. voltage would be distorted from the sinusoidal form.

The distorting effect is increased if the reactor is operated at a still higher flux density below saturation value and is also increased if a greater change of flux density is to be produced off the linear part of the magnetization curve. For example in order to vary the flux density between the limits B_9 and B_{10} the alternating magnetizing force would require to be varied between the limits H_9 and H_{10}, and a sinusoidal variation of flux would require a far from sinusoidal alternating magnetizing force. Due to the distortion of the a.c. magnetizing force wave the zero of the a.c. magnetizing force wave moves from Q-R to S-T, and the effective value O-H_9 of the d.c. polarizing field actually requires a polarizing field O-H_p to produce it. The effect is that of an apparent direct current induced in the a.c. windings in opposition to the control current. Under the operating conditions in a modern amplifier the effective polarizing force may be less than one tenth of the applied magnetizing force.

If the control current is increased so that the reactor operates well on to the saturated portion of the B/H curve, there will be no change of flux density in the core if the applied alternating magnetizing force is varied, say between the limits H_{11} and H_{12}. Neglecting secondary effects the reactance of the a.c. load windings will then be zero, and maximum load current will flow. In this way the effective (virtual) value of the alternating load current can be varied by variation of the controlling direct current.

Direct current measuring circuit

Saturable reactors in which the control current provides the whole of the mean excitation of the core (non-feedback reactors) may be designed to have a fairly linear relationship between the input and output characteristics. Such reactors have a comparatively low gain, but are suitable for controlling lighting circuits, etc., and for measuring large direct currents. There is the

advantage that the measuring instruments can be isolated from the power circuit.

Fig. 6 shows a direct-current measuring circuit in which two tape-wound reactor cores of material having a rectangular hysteresis loop are used. The core material has a very high and almost constant permeability up to saturation flux density, beyond which further increase of M.M.F. produces very little increase of flux. The a.c. windings N_1 and N_2 are connected in series so that when the output M.M.F. assists the control M.M.F. in one core it opposes that in the other, thus electrically neutralizing induced voltage of supply frequency in the primary (control) conductor. Due to the fact that a one-turn primary is used, induced voltages of second-harmonic frequency are negligible. Fig. 7a shows the a.c. voltage wave V, and Fig. 7b, the direct current I to be measured. Fig. 7c shows that the alternating load current I_1 has an almost rectangular wave form, and the rectified current I^1 passed through the ammeter has almost a constant value with a constant busbar current I, as in Fig. 7d.

Parallel-connected load windings

With series-connected control windings having a large number of turns, considerable voltages of second-harmonic frequency may be induced in these windings. However, the load windings on the two reactor cores can be connected in parallel to provide a short-circuit path for induced second-harmonic frequency currents so that these will have little effect on the control circuit. Fig. 8 indicates the effects in such a circuit having parallel output windings with mutually reversed series-connected control windings, assuming that the resistance of the load is infinitely less than the impedance of the reactor when unsaturated with zero control current, and that the impedance of the reactor is negligible when the cores are saturated. The magnetization characteristic can then be represented by three straight lines as in Fig. 8a. In Figs. 8c and 8d are indicated the constant control M.M.F. (I_cN_c), whilst in Figs. 8f and 8g are shown the net M.M.Fs acting with the sinusoidal a.c. voltage of Fig. 8e. The apparent circulating currents in the output windings are indicated in Figs. 8j and 8k, the actual currents being indicated in Figs. 8m and 8n. The flux density in the reactor cores varies as shown in Fig. 8l. The volt drop across the reactor is given in Fig. 8p, so that the voltage V_r which would be applied to a resistive load in series with the reactor would be as given in Fig. 8h.

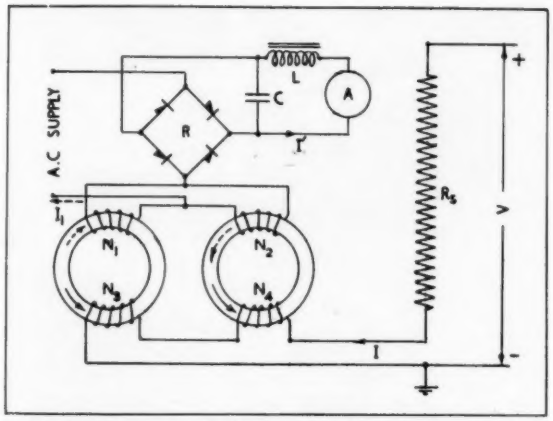


Fig. 9.—Parallel-connected saturable reactor circuit for measurement of high d.c. voltages

Fig. 9 shows a circuit in which saturable reactors are used to measure a high d.c. voltage V. This is applied to the series-connected control windings N_3 and N_4 through the series resistor R_s so that the current I is proportional to V. The parallel-connected load windings N_1 and N_2 are used to limit induced currents of second harmonic frequency in the control windings. The load current I_1 has a sharp-pulsed wave shape, roughly of the form indicated in Fig. 8h, but the rectified output current I^1 is smoothed by the capacitor C and the indicator L so that it is almost constant if V is constant.

Radioisotopes Aid Research in Glass Industry

Radioactivation analysis and investigation of glass flow and mixing

At a symposium arranged by the Society of Glass Technology (Journal of the Society of Glass Technology; Volume XLII, No. 205, pages 55-118T) speakers from the Glass Industry and the Atomic Energy Research Establishment described the many uses of radioisotopes within the industry. Gamma-radiation techniques have special advantages in measuring the level of glass in, for example, glass furnaces and feeders where high temperatures render access difficult.

The total quantity of selenium left in a glass after the addition of a decolorizer can be determined by irradiating in a nuclear reactor samples of the glass with and without the selenium additive. By comparing the resulting gamma-radiations with a differential type of scintillation spectrometer, selenium contents of 10 parts per million are readily determined. This use of inactive tracers revealed by radioactivation analysis is of wide potential application in production processes where radioactivity in the product has to be avoided.

The flow of glass in a number of tank furnaces has been investigated by adding a small amount of radioactive tracer to the glass melting batch and then measuring the amount of radioactivity in the glass containers produced, the tracer consisting of a glass containing active phosphorus.

Using tantalum as a non-radioactive tracer, both the rate of throughput and the degree of mixing in a glass-melting tank furnace have been assessed. After the addition of a small quantity of tantalum pentoxide to the glass batch, the relative amounts of tantalum appearing in the product can be determined by irradiating samples of the glass in a high flux of neutrons followed by the measurement of the activity induced in the tantalum present in the glass. Different amounts of sand labelled with an equilibrium mixture of ^{140}Ba and ^{140}La have been successfully used to trace the passage of sand through a sand washing and grading plant and thence through a glass-melting tank furnace.

The Churchill Model NB 18 in. × 6 in. horizontal spindle surface grinding machine fitted with a Diaform grinding wheel forming attachment

Toolroom Horizontal Surface Grinder with Wheel Forming Equipment

A small capacity horizontal spindle surface grinding machine eminently suitable for toolroom or general purpose work has been recently introduced by the Churchill Machine Tool Company Limited, Broadheath, Manchester. Complete with a Diaform grinding wheel forming attachment mounted over the wheelhead, the machine, Model NB has a 18 in. × 6 in. work table with 9 in. capacity between the table and a new grinding wheel. The table longitudinal traverse can be operated by hand or hydraulically with speeds steplessly variable up to 60 fpm. A safety interlock is incorporated between the hand and power traverse so that the handwheel is automatically disengaged when the hydraulic traverse is in motion. Simple means are provided for disconnecting the power traverse when the hand motion is required for long periods of operation. Lubrication of the slideways is continuous and automatic by means of spring loaded oil rollers secured within oilboxes in the lower slides.

The hydraulic cross feed of the intermediate slide carrying the work table operates automatically at each reversal of the traverse stroke, the feed being variable from 0·008 in. to 0·06 in. Maximum cross traverse is 7 in. and over-run is eliminated by adjustable safety trips interlocked with the feed. Course and fine hand feeds are available, with fine adjustment to 0·001 and if desired a "click" fine feed giving adjustments to 0·0001 in. can be supplied. The cross feed can be securely locked to prevent movement when form grinding. To combat wear of the relatively short cross slideways of this type of machine, hardened steel inserts are fitted in both the bed and the saddle and lubrication is continuous and automatic. The cross feed screw and nut are oil bath lubricated.

The grinding wheelhead is mounted as a unit on top of the box shape column casting, which moves vertically in a dovetailed slide at the rear of the body. The slideways are exceptionally long and fully protected.

The wheelhead is of very sturdy construction and is fitted with a Nitralloy steel spindle running in automatically lubricated solid cone adjusted bronze bearings. The design ensures that the bearings give the maximum possible support to the spindle with the minimum oil film thickness for maintaining efficient lubrication. The standard grinding wheel of 8 in. dia × ¾ in. width can be increased to 1½ in. width when specially ordered for plunge cut and form grinding. A 1 hp flange mounted motor on the wheelhead column drives the grinding spindle by V-belts which are fully enclosed by a cover plate.

The grinding wheel down feed is arranged with both coarse and fine movements, the latter being by means of a "click" feed in increments of 0·0001 in. which can be both felt and heard as ball plungers click into micrometer locating holes so that observation of the work and the grinding wheel by the operator is not interrupted. A safety device ensures that vertical fall of the grinding wheel cannot possibly occur other than by the operation of the feed handwheel.

All controls are positioned below the level of the work table to give maximum operating convenience and the electrical control equipment is neatly housed in the machine on the inside of a hinged cover. The hydraulic system is maintained by a gear type pump part submerged in the oil reservoir and driven by a 1 hp motor.

A wide range of ancilliary equipment is available to greatly extend the scope and usefulness of the machine. It includes the Diaform grinding wheel forming attachment high speed grinding attachment, various fixtures and universal tilting vices, wet grinding equipment and wheel crushing equipment.

Our illustration shows the Churchill NB machine fitted with the Diaform attachment Model 5/1 which is designed specially to be mounted directly on the grinding wheelhead and to remain in that position during the grinding operation.

The attachment is fitted with an adjustable template mounting carrier incorporating a slide and handwheel with ·001 in. graduations, to facilitate final alignment of the template form and Diatipt diamond tool in relation to the grinding wheel. Maximum movement of the template carrier is 0·50 in. either side of its normal centre. A further hand wheel with 0·0005 in. graduations is provided for applying the feed when forming the grinding wheel. This can be withdrawn a maximum of 3½ in. when setting up the Diatipt diamond tool by means of the dial indicator provided. The knurled knob on the end of the diamond spindle is to facilitate easy rotation during this setting operation. Incorporated on the upper side of the carriage unit is a water cooled jacket to ensure that the accuracy of the Diaform is unaffected by the heat normally generated by the grinding wheel spindle.

The pantograph reduction of the Model 5/1 is 10:1 and profiles up to 1 in. wide × ½ in. deep can be obtained. A Model 5/2 is also available, the reduction being 5:1 which produces profiles up to 2 in. wide × 1 in. deep.

The selling agents for Churchill machines in this country are Charles Churchill and Company Limited, Coventry Road, South Yardley, Birmingham.

Manganese Steel in Industry

Irrespective of the particular industry, the toughness and abrasion resistance of austenitic manganese steel (11–15% manganese) are qualities without which plant and equipment will cost more to maintain, and finished products will cost more per unit or ton of weight. Manganese steel is not indispensable, but wherever long service is worth money, it is ultimately more economical than other materials lower in first cost. It is mainly used in cast form, and the following notes indicate some of the principal uses

POWER shovels do not always deal with the hardest of raw materials, but when handling limestone, clay, shale, etc., the dippers, dipper teeth and shovel wearing parts are often made as manganese steel castings. Another important use for manganese steel is for the wearing parts of gyratory, jaw, roll or swing hammer crushers, and in grinding mills and pulverizers. It is, of course, possible to employ less expensive materials, but the curious fact that this steel work-hardens on the surface as soon as it is cut or abraded makes it outlast the other materials many times, except where the conditions involve a risk of spreading because of heavy impact. In such circumstances a special chromium alloy steel is often used as an alternative.

Manganese steel can also be used to advantage in wearing parts of screens, elevators, conveyors, pumps, etc.

Gears and pinions in heavy power transmission work are usually subjected to severe shock loads, together with exposure to gritty particles causing rapid wear in ordinary ferrous metals. The successful performance of equipment depends largely on the ability of gears and pinions to stand up under heavy loads and to resist the wearing action of abrasive materials. Manganese steel gears and pinions are economical for this type of work because they withstand, without fracture, shock stresses that would destroy gears made of other materials; they resist the wearing action of gritty materials; and the strength of the steel is not necessarily associated with bulk. In many instances the castings can be made lighter in weight by coring them, yet they will still show a greater endurance than heavier parts of ordinary steel or iron.

In substance all metals are made up of minute particles or grains. Their ability to withstand fracture depends on the ability of the particles to adhere to one another. Manganese steel has a structure of great density, its particles being more closely combined than those of ordinary steel. In fact, the grains are so tightly held together that great shocks and stresses can be sustained without the pulling apart or fracturing of the structure.

Under abrasive or frictional wear, the teeth of manganese steel gears and pinions take on a high polish so that friction is reduced. The dense structure enables manganese steel to retain this smooth surface at the points of contact, and the abrasion of the material is retarded rather than accelerated as it proceeds.

This polished surface of manganese acts as a good lubricant in overcoming wear. Sharp dust, grit and other abrasive materials cannot readily work into the slippery surface of the close-grained metal. Where oil and grease would form means of attachment for the grinding particles in the surrounding air, manganese steel gears and pinions under dusty conditions run smoothly without lubricant. This inherent self-lubricating quality adds to the abrasion resistance of the steel.

Ordinary steel and iron wheels frequently fracture or crack when subjected to sudden shock because inherent stresses in the metal are released. The homogeneous austenitic structure of manganese steel minimizes such fractures even if the wheel is subjected to severe shocks or other stresses. The wear of wheel treads is also a source of trouble. Cast iron or steel treads sometimes wear with great rapidity because they have only a line contact with the rails. Microscopical examination at this line of contact shows a constant minute cracking of the surface under heavy loads. Wheels having rolled steel tyres behave somewhat better because the metal is less rigid; but wheels of manganese steel, because of the ductility of the metal, present a tread surface of great toughness and one that is slightly yielding. As a result, they will run for long periods with negligible wear.

The flanges of crane and truck wheels are particularly subject to constant shock, but manganese steel wheel flanges are so tough that fracture is unusual, even when considerable end thrust is encountered or when the wheels are cramped. The high tensile strength and ductility of austenitic manganese steel enable the designer to design lighter wheels in many instances, while yet producing a wheel stronger than the original heavier ordinary steel wheels. This not only saves expense, but also means less dead load to be hauled and a more rapid handling of trucks and cars.

In one instance, manganese steel effected important economies when used to replace cast iron sheaves in the steel rope blocks and on the drag lines of a locomotive crane, which handled a minimum of 300,000 tons of material a year. After three years of service, the grooves were as smooth and bright as when new, and wear was negligible. It was forecast that ten to fifteen additional years of service could be expected; five sets of cast iron sheaves would have been necessary during the three year period, as well as additional cable.

Rotary cement kilns are supported between the ends, as they revolve, by rollers upon which ride the tyres, placed at intervals around the shell. The weight and consequent pressure are heavy, and considerable wearing action is involved. Manganese steel is often used for the rollers, some of which weigh 884 lb each and are 26 in. dia.

Manganese steel has been used with outstanding economy for many years in mills for the fine grinding of ores, cements, etc., because of its stress-resistance and ability to withstand severe abrasion. Here, as in many

other instances, the somewhat higher first cost is more than offset by higher production, fewer shut-downs, and lower upkeep expense.

Pulverizer hammers used for pulverizing hard materials in rotary pulverizing machines involve impacts at high speeds which would fracture ordinary hammers of carbon steel and probably wreck the machine. Manganese steel hammers merely work-harden and have a much longer life unless exceptional conditions obtain. Their toughness absorbs the heavy impact and allows the typical surface cold-working to harden the skin of the steel, so reducing wear.

Manganese steel pulverizing hammers are also economical when softer and more friable materials have to be pulverized. Their toughness avoids breakages. The same steel is also suitable for liners, breaker plates, grids, etc.

The quarry industry makes great use of manganese steel. The first stage after the raw material has been quarried is its reduction in a primary crusher, which may be of jaw, gyratory or of special hammer mill type, according to the material to be crushed. Mostly, however, jaw crushers are used in which the lower end of the swing jaw stock is a renewable manganese steel toggle seating, though for reasons earlier indicated, special chromium alloy steel may be adopted as an alternative. The swing jaw stock in many crushers is fitted with reversible jaw faces of manganese steel, while renewable manganese steel cheek plates protect the sides of the crusher body from wear. The pitman is fitted also with renewable manganese steel toggle seatings at the lower end, or alternatively chromium alloy steel may be used.

Gyratory crushers have manganese steel mantles. Hammer mills for use on difficult and sticky materials have hammers and liners of manganese steel, as well as heavy breaking blocks, of the same metal, corrugated to present the maximum surface for crushing. Renewable screens or grids of hammer mills are also usually of manganese steel.

In secondary crushing, the raw material is reduced to a fineness suitable for feeding to a grinding mill. If crushing rolls are used instead of hammer mills for this work, the high speed roll shells are made of austenitic manganese steel wherever the material to be reduced is suitable. In other instances chromium alloy steel is used. The shells are plain and ground on their faces to remove irregularities.

Tube mills are used for fine grinding after secondary crushing. In a combination tube mill there are two or more sections divided by specially designed diaphragms fixed in the interior of the mill. The first section contains the steel grinding balls of large diameter, and the finishing sections have smaller steel balls or other grinding media.

In these mills chromium alloy steel is usually preferred to manganese steel, and is used for diaphragm grid plates, slotted and secured at the centre of a low carbon steel plate. Ribs cast on the back of the grid plates lift the ground material from the mill periphery to the centre, for discharge through a trunnion.

In coal grinding, one type of mill has a manganese steel renewable disc in the bottom.

In drying machinery, manganese steel is widely used for the tyres and grid bars. In the disintegration of asbestos it is used for the crown plates of the disintegrators. In excavating it is used for dipper fronts, side knives, bucket teeth and points. In dredging it is valuable because the detachable lips of the buckets, the tumblers over which the bucket chains revolve, the links, pins and bushes used in the bucket chain, are all made of manganese steel in many instances because of the exceptional resistance to abrasion and wear afforded.

The railways use enormous quantities of manganese steel for their points, switches and crossings at parts of the track subjected to extra-heavy wear. Such tramways as still exist also use points and crossings of cast manganese steel.

No satisfactory explanation has yet been found, or if proposed, completely accepted by metallurgists, for the work-hardening property of austenitic manganese steel. The property has one drawback, namely, the difficulty of machining the steel with ordinary materials and techniques. Manganese steel can, however, be successfully machined as a commercial proposition by the use of special tools made of super high speed steel, and a technique the main characteristic of which is drilling *dry*. There is no exceptional difficulty in the machining process as long as the technique is correctly followed. For drilling holes in manganese steel, a special design of twist drill has been invented and is perfectly successful. Manganese steel can also be successfully hot punched.

Where gears are made of austenitic manganese steel, the cutting of the keyways presents difficulties but this can be overcome by inserting mild steel bushes in the bores and machining the keyways in these.

The cost of manganese steel, though admittedly higher than that of mild steel or other steels, is not so high as to render its use prohibitive, and if careful records are kept, it will be found that the savings effected by its use greatly exceed the advantage in price of the less wear-resistant materials.

Manganese steel can be obtained in the form of rolled bars as well as in cast form, and forgings can also be obtained. To give the steel its full wear-resistance when supplied in the rolled or forged conditions a quenching treatment is necessary, but this is relatively simple, presenting no special difficulties.

Short Circuit Testing Miniature Circuit-breakers

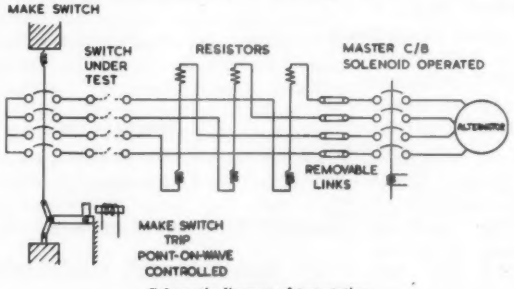
A test station offering ideal facilities for observation and performance rating

THE production of electrical wiring accessories and circuit breakers calls for constant research into both manufacturing methods and performance and quality of the finished product. From its inception in 1919 J. A. Crabtree & Company Limited, Lincoln Works, Walsall, Staffs have conducted a policy of research in laboratories equipped for exhaustive electrical, metallurgical and chemical tests. The electrical laboratory for instance has a wide variety of measuring instruments for the examination and recording of transient phenomena, apparatus for electrical testing at elevated temperatures and humidities and specialized equipment to meet American, Commonwealth and European specifications. A special soundproof room is provided for life tests on such apparatus as contactors which extend over many millions of operations. Another room has been

Left, apparatus in the test cell ready for trial. In the foreground the push-button control desk for the entire installation. Right, room with forced ventilation housing the 800 kVA alternator, starter and resistors

equipped for contact life tests under practical conditions involving the actual starting and stopping of motors.

The latest addition to the laboratories is a short-circuit testing station designed for circuit-breaker and contactor testing. An 800 kVA alternator with a rotating salient pole field provides a 440V 3-phase supply, and is driven by a 100 hp squirrel cage motor with a synchronous speed of 1500 rpm. The speed is controlled by an auto-transformer starter employing a Korndorffer circuit and the two machines directly coupled are mounted on a common bedplate. Current is fed direct from the alternator terminals to a main circuit-breaker which has a normal continuous rating of 1000 amp and a breaking capacity far in excess of the maximum short-circuit current of the alternator. Leading from the alternator is a network of underfloor busbars terminating in the adjacent testing room and reactors



Schematic diagram of test station

and resistors connected are in each phase so that prospective current and power factor can be controlled down to 100 amp.

The machine with its starter and the circuit-breaker, the resistors and the reactors, are situated in a specially built room which has forced ventilation, the cooling air for the motor and alternator is supplied in excess of 4000 cfm and filtered to exclude dust. Interlocking controllers ensure a normal supply of cooling air before the alternator equipment is started.

The test room contains a push-button control desk for remote control of the entire installation, and a vertical panel for mounting the item under test. A protective screen is interposed between them, and fully automatic safety devices and signals are incorporated in the control desk. The actual test is carried out by pressing a "make" switch which is provided with an electronically operated point-on-wave control. During the test oscillograms are prepared which can be processed in an adjacent dark room.

The test room is also provided with a d.c. supply from a stationary battery capable of giving 5000 amp at 250 V and over 2000 amp at 500 V. Suitable control resistances are situated in the test station and provision also made in the busbar system for the connexion of transformers for higher test voltages if required.

The testing station has been arranged particularly to suit tests on apparatus intended for manual operation by unskilled operators—for example, miniature circuit-breakers which may be installed in domestic premises or institutions and re-closed after a short-circuit—and to observe the action of the circuit-breaker at close quarters and in quiet conditions.

NYLON FACED HAMMER—The toughness and durability of nylon coupled with its excellent shock absorbing qualities make it an ideal material for soft-faced hammers. This Thorex hammer, made by the Thor Hammer Company, Highlands Road, Shirley, Birmingham, has replaceable screw-in faces 1¼ and 1¾ in. dia. Shortly available will be 1¼ and 2 in. sizes. The makers state they will be pleased to supply a free test sample to any Works Manager or Buyer who applies

Engineering Drawings for Services Equipment

The intention of the Services to have all drawings of their equipments prepared to a nationalised system will require drawing offices to become familiar with the requirements of a new Defence Specification, No. DEF–33. A brief explanation of the system is given here

ON the authority of the Joint War Production Committee of the Ministry of Defence, the Engineering Standards Co-ordinating Committee has prepared Defence Specification DEF-33* which defines exactly how drawings of Service equipment are to be prepared, irrespective of who prepares them. The object is to eliminate the time-consuming and wasteful practice of re-drawing and to ensure that drawings of Service equipment, wherever made, shall provide all the information required —drawing numbers, titles, tests, specifications, materials, dimensions and tolerances—each and every one of these at the stage at which it is required to be known.

The specification supplements BS 308, which is, in fact, an essential part of its recommendations. It goes further than BS 308 as regards drawing sizes and lays down dimensions for preprinted blanks for drawings and lists with margins for binding. The standard drawing layout is designed to give maximum drawing space whilst ensuring that sufficient space is also provided in pre-determined positions for recording ancillary information.

Detail drawings

Each and every part is fully drawn, dimensioned and toleranced on detail drawings which make reference to the appropriate material, process and test specifications. Each part is drawn on a separate sheet. Standard parts, when once drawn, do not require to be redrawn for each equipment.

Sub assembly drawings and lists

Separate drawings are made for sub assemblies, showing the parts by item numbers, supplemented where advantageous by the detail drawing numbers. No reference to materials is required and no dimensions are necessary unless the sub assembly has an adjustment device and a dimension has to be set using this device at the sub assembly stage.

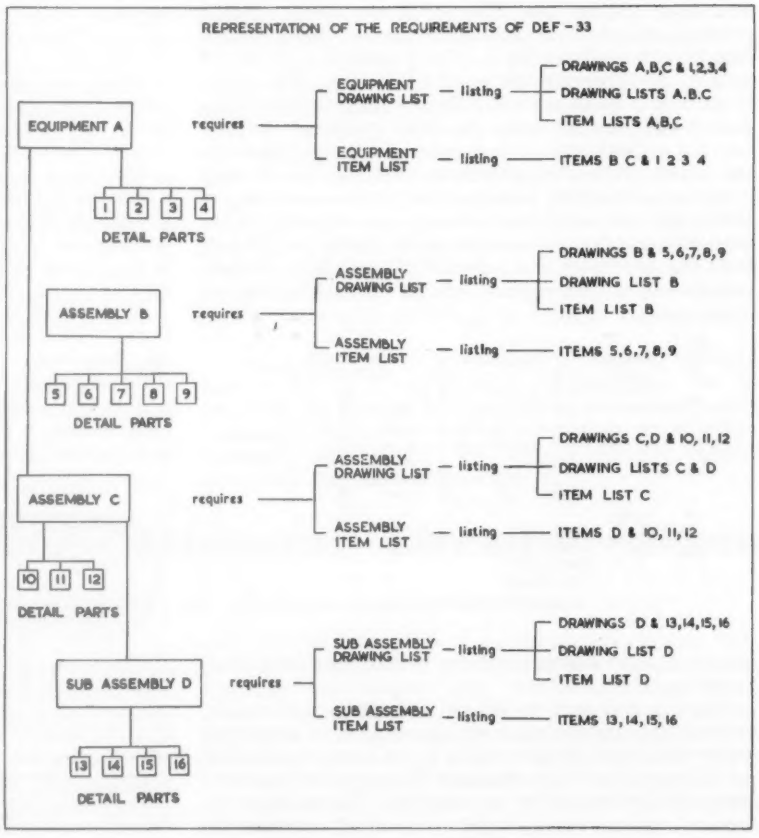
Each sub assembly has an item list bearing the same number as the sub assembly drawing and relating its item numbers to the detail drawing numbers and titles, and showing quantities.

The sub assembly may also have a list of drawings of components if it is to be purchased or stored separately from the main equipment. This shows the item list and all drawings comprising the sub assembly, with issue numbers and size references, and makes reference to relevant tests and specifications. The list carries the same number as the drawing and its item list.

Assembly drawings and lists

Separate drawings show, by item numbers, all sub assemblies and single details required to form the assembly. Each sub assembly and loose detail part, together with not drawn standard parts such as bolts and nuts, are identified on the assembly drawing.

Each assembly also has an item list bearing the number of the assembly, and relating the item numbers to the drawing numbers and titles. No reference to materials is required and



*H.M. Stationery Office, price 7/6

no dimensions are necessary unless the assembly incorporates an adjustment device and a dimension has to be set.

Assemblies may also have lists of drawings and items comprising the assemblies if they are to be purchased or stored separately from the main equipment. Drawing lists make reference to any relevant tests and specifications. The assembly drawing list carries the same number as the assembly drawing and its item list.

General assembly and arrangement drawings and associated lists

An arrangement drawing of the equipment shows the several assemblies, sub assemblies and detail parts by item numbers, together with an equivalent item list and drawing list. The drawing list for the equipment comprises an index of all that goes to make the equipment and includes reference to any assembly drawing lists that may have been prepared. It lists all drawings shown on the arrangement drawing by item numbers, size references and issue numbers, and all item lists which have not been incorporated in the assembly or sub assembly drawing lists together with their issue numbers All relevant tests and specifications are shown on the equipment drawing list.

Assemblies and sub assemblies which are not required to be purchased, stored or used separately from the equipment need not have separate drawing lists. In such cases, the parts comprising the assemblies and sub assemblies are shown on the equipment drawing list and item list.

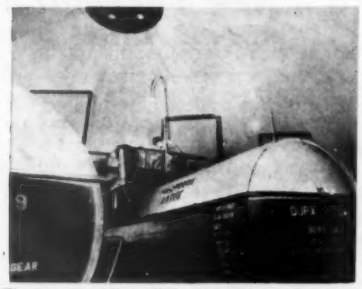
Diagram and outline drawings

Diagrams are made for circuits, wiring, piping, etc., with diagram lists. Outline drawings are made for details of space, weight and performance characteristics. Outline drawings are normally required for items of proprietary manufacture where it is only necessary to have details of physical and functional characteristics and not the full technical manufacturing information.

Bubble Building

A novel type of building, used for a number of purposes in the United States, is strikingly reminiscent of one of the proposals of the late Professor Lanchester. The example illustrated here was used by the Du Pont Company to shelter three tank cars from winter weather while they were on a railway siding, and to keep their contents—neoprene latex—at workable temperature by warming the air in the building.

The structure is a large "bubble" fabricated of 8-oz nylon coated on both sides with neoprene synthetic rubber. The interior was heated by coils in two blowers which main-



The contents of three 8089-gallon tanks were protected from winter weather by this pneumatic shelter. Warm air pumped into the neoprene-coated nylon structure made it possible for the liquid neoprene latex in the tank cars to be piped directly into process lines

tained a positive air pressure of $\frac{5}{8}$ in. water. The temperature inside was maintained at 40°F. when the temperature outside was as low as — 20°F. The fabric remained flexible and tough and free from all forms of deterioration under all seasonal conditions. This air-supported building was designed and fabricated by the Irving Air Chute Company, of Lexington.

Super Circuit Breakers

The first 275-k circuit breaker equipped for 3-phase, high-speed automatic closing, has been handed over to the Central Electricity Generating Board by the makers, the British Thomson-Houston Company Limited, after successful proving tests at Monk Fryston. It is for the super grid network, in which the standard 275-kV lenticular tank oil circuit breaker has been in operation for the past four years.

Circuit breakers with these high-speed auto-reclosing features have been supplied by BTH to authorities in many parts of the world for service on lower voltage systems (132 and 230 kV), but some circuit breakers which BTH are at present making for the Kariba Hydroelectric Scheme in Rhodesia will be for service at no less than 330-kV. The company is making 25 units for this installation, including some for 3-phase auto-reclosing, and five arranged for single-phase reclosing during the initial stages of development.

Largest Fuel Oil Terminal

The new Charrington fuel oil terminal in Poplar covers over 4 acres and is said to be the largest in the United Kingdom. Capable of storing over 4 million gallons of fuel oil for distribution in and around London the new terminal has been constructed at a cost of over £400,000.

A feature is the automatic pumping equipment which feeds the fuel oils from the storage tanks to the loading bays. This equipment, eliminating manual control, ensures that nearly 400,000 gal of fuel oil can be loaded per day and that the road tankers on site can be quickly filled for distribution with any quantity and type of product in storage.

In addition there are at Poplar a boiler house, a compressor house, a repair shop, a vehicle washdown building and a large administrative block which contains a mess room and showers for those employed on site and a centrally heated locker for every driver.

Mr. C. P. Humphris, M.A., (Cantab) A.M.Inst.F., A.C.I.S. Charringtons' chief engineer, has been responsible for the planning and construction of the terminal.

Bigger E.R.W. Tubes

The new electric resistance-weld tube mill which produces E.R.W. steel tubes up to $5\frac{1}{2}$ in. dia, with a wall thickness of $\frac{1}{4}$ in. and in lengths up to 60 ft, and which was designed by the Tube Investments subsidiary, Tube Products Limited is now in operation at the company's Falcon Works at Wednesfield. Previously, E.R.W. tubes made in this country have not exceeded $4\frac{1}{2}$ in. outside diameter. The new mill holds promise of important applications for E.R.W. tubes, which can now be made in the increased size range for boiler tubes to BS. 1654, ferrous tube to BS. 806 Class H, mechanical tubes to BS. 1775 and tubes for the motor car industry to BS. 980. Two new bays covering a floor space of 77,000 sq ft have been built to accommodate the mill and its ancillary plant. The mill can produce the new range of big tubes with a high standard of concentricity and surface finish.

Tube Products was formed in 1927 by Tube Investments to manufacture E.R.W. tubes. It was the pioneer producer in Britain. TI now has three plants in the United Kingdom producing E.R.W. tubes.

Reducing Machining Costs by Computor Control

New Ferranti developments aimed at speed and precision with economy

IMPORTANT development work in the field of digital computor techniques applied to machine tool control has been carried out by Ferranti Limited over the past year. Noteworthy among the practical steps taken by the company is the development of digital differential analysers with increased versatility. These devices can now be used for a much wider range of problems than hitherto.

Digital differential analysers are designed to generate the contour paths for the Ferranti control system in conjuction with a general purpose computor. In the more simple analysers now available, the differential digital output may control directly a digital plotting table for two-dimensional graphical display with high accuracy. By this means it is possible to reduce considerably the print-out time of a general purpose computor and to effect remarkable overall cost savings.

Digital plotting table

Another innovation is the Ferranti digital plotting table which has been designed to plot at high speed, two-dimensional digital information, in conjunction with a digital analyser attachment. It can also be operated from a suitable input as an automatic drafting machine, and in this instance use can be made of the Ferranti computor service which has been established in Edinburgh.

The M-type transmission drive motors are transistor controlled and fed with pulsed information. Each pulse (positive or negative), causes a pen displacement in the appropriate sense of one digital unit.

The machine is designed on kinematic principles to reduce drive friction, and the carriage weight is controlled to give the best possible dynamic performance. Maximum traverse velocity is 60 in./min with a digit size of 0·005 in. and overall accuracy is better than 1 in 1000. Some flexibility is permissible both on machine size and on digit size to suit specific requirements.

Digital differential analysers have been used by Ferranti Limited over the past seven years for their computor controlled machine tools, but the techniques can be used to solve any continuous computing process. For example, applications are to be found in simulators, computors for process control, and accurate multipliers. and axis transformers for analogue differential analysers. Essentially, these computors carry out a simple integration procedure at high speed. The size of the integration steps determine the computing speed and accuracy. Multi-level overflow techniques have now been developed with a thirty-fold increase in speed without sacrificing the computing accuracy.

Although these operations could be programmed on a general-purpose computor, the computing times involved are so long as to be uneconomic, due to differences in the types and layout of the logical, computing and storage elements. In addition, the one-to-one correspondence between terms of the equation and integrator units gives the engineer or mathematician an easier understanding of its contents.

Packaged units for digital differential analysers

Standard integrator packages have now been designed by Ferranti Limited to meet the demand for a real time simulator with a better accuracy than their present analogue versions. The integrators, which use serial binary arithmetic, have been arranged to operate in parallel and are connected up in a similar manner to analogue differential analysers. The accuracy can be varied depending on requirements. A 5 c/s bandwidth, for example, will give an accuracy of 0·1% which compares favourably with analogue equipment. Digital to analogue converters enable the packages to be integrated with analogue computors and control systems. If the operating speed is not an important factor, the integrators can be time-shared to reduce costs.

The packages are built up of transistorized logical elements, phasing electromagnetic delay lines and nickel delay line stores. The clock frequency is a ½ megacycle/second and the word length is chosen to give the required accuracy. Marginal checking facilities are available for testing. The logical rules and loading restrictions on the cards are simple and easy to understand and the "Meccano" type assembly of the individual components enables customers to assemble their own computors if they so desire. In addition, wiring sheets with the engineers' logic combined on the same sheet are available to keep the logic-to-wiring transfer work, with its inevitable mistakes to a minimum.

Computor controlled machining

The Ferranti system of numerical control of machine tools has been one of the most successful so far developed in either Britain or the U.S.A. The control equipment which is associated with the machine tool is designed in such a way that it can be applied to almost any machining problem, irrespective of machine tool size.

A digital differential analyser is used to process the information which is taken from an engineering drawing thus reducing the programming effort to a minimum. No mathematical knowledge is required of the programming engineer, who may very well be the man who is at present operating the conventional machine.

A co-ordinate drawing is made of the component from which the programme engineer makes out the programme. Once the basic information has been written in, for example, cutter diameter and feed rate, the programmer is concerned solely with the dimensions of the part and the path which the cutter is to take.

The programme is typed on a teleprinter to produce five-hole paper tape representing the input of information to the computor which accepts this information and calculates the continuous path of the tool. The output from the computor which is the input to the control console takes the form of lines of pulses on magnetic

tape, one for each axis of the machine tool and one for checking purposes. The control console continually checks on its own performance throughout machining.

Users of controlled machine tools do not necessarily have to own a computor as data-handling of the Ferranti system is based on a Central Computor Service at Edinburgh from which a 24-hr service can be obtained. This centre is at present supplying tapes for controlled machines distributed throughout Britain.

Apart from this method, the association of a general purpose computor in conjunction with a digital differential analyser can prepare the machining information in a similar manner for even the most complicated three-dimensional machining problems. It is anticipated that such an installation will be in operation at the company's Computor Centre at Portland Place, London, early next year.

Application of Ferranti system

A collection of programmes is available to handle special purpose three-dimensional machining problems. For example, turbine blades, compressor blades, water runners and ships propellers can be produced on a controlled machine tool without the use of expensive masters. Using a three-dimensionally controlled shaping machine a 6 in. blade can be produced in four minutes to an accuracy of $\pm$ 0·001 in. with a computation cost of less than £30. This application serves to illustrate the advantages of the Ferranti control system. Again, a three-blade ship propeller of 4 ft dia can be completely machined in 15 hr. No drawings are required as the information to the computor can be taken direct from the hydrodynamist's figures. The computation costs are of the order of £60 which is only incurred once for each set of propellers. From hydrodynamists' figures to a completed ship's propeller will therefore take less than three days compared to anything up to three months by existing methods.

The cost to produce templates and cams can also be substantially reduced. Using a medium sized machine tool, intricate template profiles can be machined at a cost of approximately six shillings per foot run compared to conventional costs which can be as high as £2 per foot run.

Continuous Casting

Twin-stand development gives greater reliability and flexibility

THE continuous casting machine at Barrow Steel Works Limited, where experiments in the continuous casting of steel have been in progress since 1952, has been modified so that twin-strand continuous casting of billets and small slabs is now possible.

The modified machine, which has double the capacity of the former unit and is equipped with automatic control, operates at speeds of between 220 and 360 in. per min when casting 2-in. square billets—at least twice as fast as any other known continuous casting plant. Normal performance with billets of this size is a production rate of 15 tons per hour. Despite these high casting speeds, the machine is only about 29 ft tall to the top of the mould, the latter being 32 in. long.

Hot metal for the process is supplied from a 7½-ton capacity electric arc furnace, which is tapped into a preheated ladle of the same capacity. Steel is teemed from the ladle into two separate tundishes simultaneously, a small transverse launder being used to divide the metal supply. The tundishes, like the ladle, are preheated and fired during casting by means of specially developed oil burners. An anti-swirl nozzle of Barrow design fitted to the bottom of each tundish ensures an even and steady flow of metal into the mould.

On emerging from the reciprocating copper mould, the billet passes through a series of water sprays and is solidified before it reaches the withdrawal rolls. At the base of either strand there is a single pair of rolls actuated by a power cylinder which bends the billet in order to discharge it horizontally on to a roller path, where it is straightened under its own weight and then cut to length. The extent of the cooling bank facilities available determines the length of the billet; lengths of up to 150 ft have been obtained, though 30 ft billets or shorter are standard practice.

Automatic control devices are employed to stabilize the level of the liquid metal in the mould during casting. This leads to greater reliability in operation as the entire production sequence proceeds automatically from the moment when casting begins; it also aids uniformity and consistency in the finished product. By giving greater flexibility, the twin-stranding arrangements ensure greater reliability and little or no loss of yield. Because of the close temperature control exercised, casting times may last up to 1¼ hr; longer casting periods are feasible and for a 7½-ton cast have been extended to two hours without adverse effects on the steel.

The twin-strand plant at Barrow is designed to produce billets from 2-in. to 4-in. square and slabs up to 12 in. by 4 in. Much of the experience gained so far has been in the range of carbon steels containing between 0·05% and 0·85% carbon. For these steels, the average yield of commercially sound material runs between 98% and 99%. Equally good yields have been obtained with low alloy steels, including silico-manganese spring steel and high sulphur free-cutting steel, and stainless steels. In subsequent rolling and forging processes, continuously cast billets and slabs have shown physical properties fully comparable with those produced by conventional methods.

Instant Drying Ink Package Marker

A LARGE-CAPACITY marking pen fitted with a compressed felt nib which will write or stencil on practically any kind of surface should prove to be invaluable for warehousemen, store keepers, etc.

The marker, made by Ofrex Limited, Ofrex House, Stephen Street, London W1, is of patented construction and gives a completely controlled and even flow which is maintained without the use of any valve mechanism inside the barrel.

The felt nib is available for different types of marking; the marker is charged with Ofrex Rapidry ink, a patented fluid which dries instantly on paper, cloth, wood or any slightly porous surface and which very quickly dries upon hard or glazed surfaces. Whilst the drying action on application is almost instantaneous, the ink, which is available in a wide range of colours, is specially formulated to prevent it drying out in the pen.

technique

devoted to the discussion of practical problems. Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance. Payment will be made for published contributions.

Any Questions ? We welcome inquiries concerning difficulties arising out of our readers' general work, for treatment in the **technique** section. The full name and address of the writer (not necessarily for publication) must accompany each communication

Special Purpose Lathe Shaping Attachment

The lathe is recognised as being the most versatile of all machine tools, and it has been truly said that every known machining process is possible on the lathe. When occasion requires it an alteration to a lathe can turn it into a special purpose machine tool, thereby saving expensive jigs and the further loading of another machine tool which is already well burdened.

Generally, the modification warrants a reasonable general overhaul —worn slides and bearings coupled with index screws and nuts are suggestions which usually need carrying out, and when the headstock spindle is dismantled this presents an excellent opportunity to grind the chuck locating diameter and so again restore its accuracy. The replacement of other worn parts will present themselves as work proceeds.

Shaping on a lathe is not usual but in the smaller workshop not well blessed with machines of every description and size, an attachment of this nature can be a useful addition. The machine forming the basis of the present notes was a 4 in. old-type centre lathe having a flat belt drive to the headstock and a narrow gap bed as illustrated in Fig. 1. The gap allowed the fitting of an indexing and locking plunger immediately underneath the faceplate A.

The saddle was free to slide along the bed as the pinion had been removed from the rack. A rather free fit reduced friction and made the operation of the slide less tiring.

There was no point in retaining the tool box for holding the tool bar as it was not of sufficiently robust construction, so the tool bar B was bolted directly to the top slide, giving a somewhat more substantial job. Vertical adjustment of the bar was simply by the use of packing blocks.

The tool was made from a piece of round high speed steel and had a knurled screw behind it to provide downward movement, and a side grub screw to hold it securely. The clapper box swung about a lug on the top of the long tool bar B, and the box C bore against the bar at X each time the cut commenced.

A T-slot in the upper surface of the cross slide provided anchorage for the pivoted link with a special tee bolt as bearing. A plate clamped to the bed by a bolt passing through in the manner often used for holding the tailstock, secured the fulcrum at any desired position along the bed.

Fig. 2 gives details of the clapper box and indicates how vertical adjustment was made. A flat was machined on the side of the tool and a pin

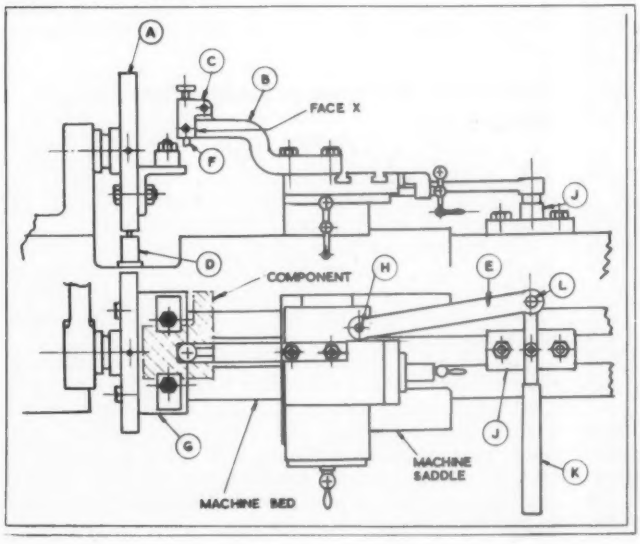


Fig. 1.—Simple angle plate fixture used to hold component for shaping. No stop was installed to limit travel of saddle. A, faceplate; B, tool bar; C, clapper box; D, indexing plug; E, pivot bar; F, tool; G, work carrier; H, pivot pin; J, plate; K, operating handle; L, pivot pin

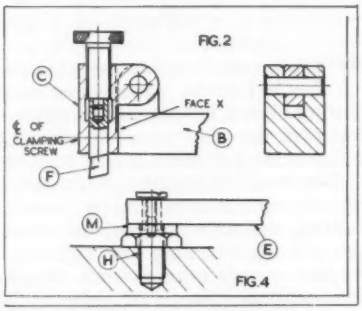


Fig. 2.—Clapper box, showing how the tool is raised or lowered. B, tool bar; C, clapper box; F, tool. Fig. 4.—Pivot secured to saddle. H, stud; M, locknut

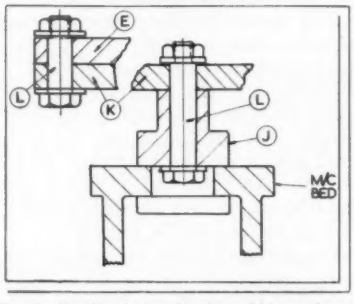


Fig. 3.—Details of pivot bearings which require no bushes. E, pivot bar; L, pivot pin; J, plate; K, operating handle

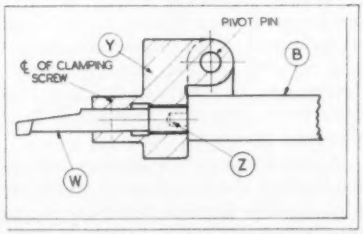


Fig. 5.—Tool holder for horizontal slotting. B, tool bar; W, tool; Y, clapper box; Z, adjusting grub screw

prevented the tool turning under the action of the adjusting screw.

The pivot bearings are shown in Fig. 3. They operated for years without bushes and the slight degree of slackness now apparent in the bearings does not prevent first-class work from being obtained.

Fig. 4 gives more detail of the locking arrangement for the pivot bar E. As the setting was usually maintained for a period the provision of anything of an elaborate nature was unnecessary.

Another use found for the machine was the machining of square, rectangular or hexagon holes without the use of broaches. The tool was changed for one set horizontally and by combining the cross slide motion with that obtained by the ram the tool produced one side of the hole. Indexing by turning the faceplate presented another setting. Fig. 5 shows tool and holder with adjustment effected by the grub screw Z. A single clamping screw was enough to secure the tool.

Two-jaw Chuck Operated by Collet Closure Spindle

Simplicity and improvisation is often the keynote of production and there are many occasions when it becomes essential to devise some special piece of equipment in order to utilise existing machines or accessories, and the reconstruction of an old lathe gave the opportunity of introducing a specially designed capstan turret and so allowing the rapid production of small parts of the type seen at Fig. 1. However, the turret was merely a simple indexing head with a clamping screw to hold it securely after positioning; what was needed for quick and accurate clamping because of the lack of a suitable air supply, was a means of operating the chuck instead of the orthodox key, especially as the latter could frequently exert too much pressure and so distort flimsy components.

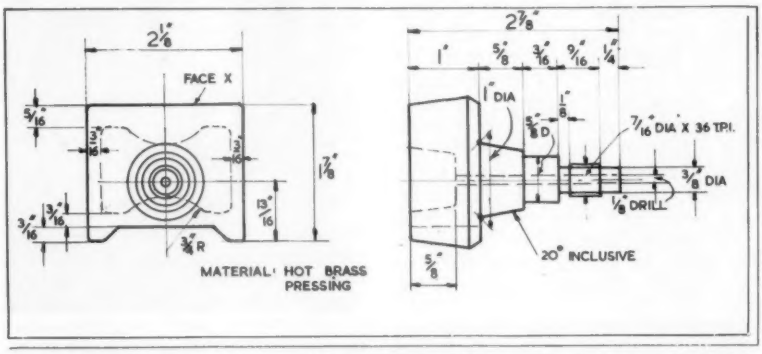


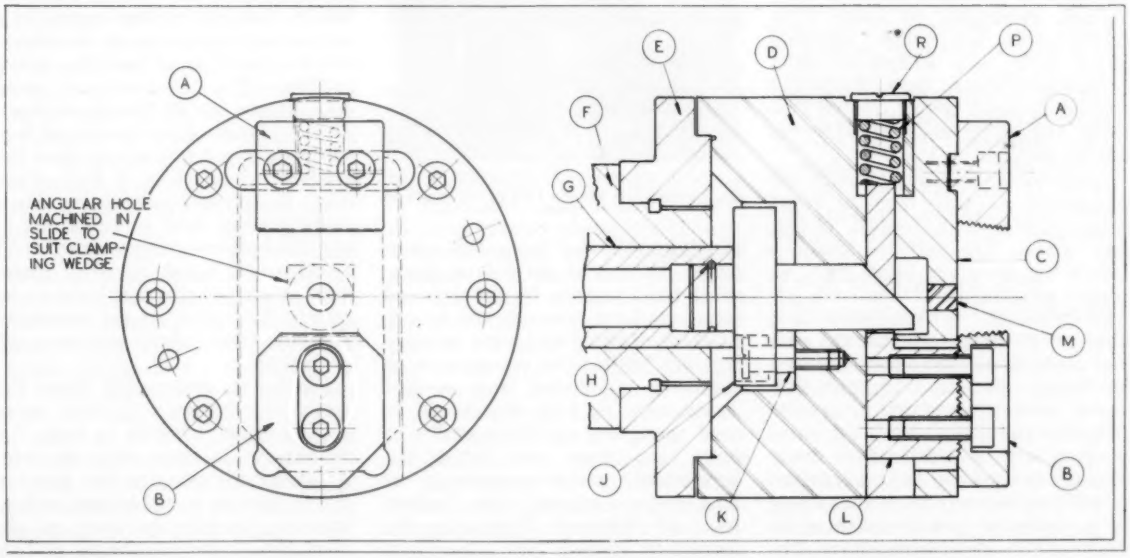
Fig.1 .—This hot brass pressing is turned and threaded at one end. The pressure exerted by a two jaw chuck is enough to hold it

Fig. 2.—This chuck utilizes the collet spindle as a tightening medium. The spindle passing through the headstock presses against the clamping wedge

The design illustrated at Fig. 2 required a complete set of parts as nothing of an existing nature was applicable or of the size suited for the machine, and though the details were largely made from scrap ends of bar, the resulting accessory, in addition to being operationally satisfactory, also had all the appearance of machine tool practice.

Two jaws were employed to locate and hold the hot brass pressing mentioned above, and the lateral location was taken from the V-stamped in the component, while the actual position of the turned shaft was assured from the straight rear surface X, Fig. 1. The fixed jaw A was tenoned and screwed to the cover C and the face serrated and angled to match the draught imparted to the stamping. The moving jaw B was also serrated with an additional set of grooves underneath; grooves which, when the screws were loosened allowed the jaw to be advanced or withdrawn and so permitted some degree of adjustment for larger components.

The body D was a large piece of steel bored to receive the clamping wedge and milled away to form a slideway for slide L; the cover was



attached to the body by socket-headed screws and held the slide in position yet allowed it to move up and down under the action of the clamping wedge. The movement was produced by the taper slotted in the slide and the angled portion on the detail J.

In the design of this wedge two factors were considered—it must not turn when disengaged otherwise the position of the two angles would be lost, and it must not withdraw too far or there would be a danger of its dropping away from the chuck body. To overcome this possibility, the headed screw K was introduced; it provided radial location of the wedge and ensured that the angles were always in relation with each other, and because of the head the collet spindle could only withdraw it until the bottom of the recess contacted the screw head, then all lateral movement ceased.

While a simple pushing motion created by the action of turning the handle or wheel attached to the collet would move the wedge forward sufficiently to cause the moving jaw to clamp the component, withdrawal by mechanical means was required, and this was achieved by the well-known and simple cross pin H; a certain degree of free movement was necessary in the groove in which this item rotated to avoid pressure on the pin.

A quick spin of the collet spindle wheel withdrew the wedge but such an action would not release the jaw enough to make it easy to lift the pressing from the chuck, and for this reason a heavy gauge spring P was incorporated. This pressed directly on the end of slide L and provided enough movement to keep it in contact with the wedge. As only about $\frac{1}{8}$ in. was needed to make component release easy, the collet spindle required about one or two turns. The spring was retained by the headed plug R.

Cleanliness is essential with all equipment of this type as swarf causes stiffness and eventual seizure, and makes dismantling necessary before the parts are freed. For this reason movement of the moving jaw was restricted to keep the hole covered no matter whether the part was clamped or the chuck awaited a workpiece. Second, a location hole bored in the cover plate to make the manufacture of that detail easy, was plugged with a soft lead or brass member as shown at M; brass driven in will hold securely but if a lead plug is preferred a groove to form an anchorage is perhaps necessary. The open end of the milled slot for the slide is blanked off by the slider itself as this completely fills the aperture.

Despite the statement that scrap pieces were used for the parts, it should be observed that, generally, low-grade mild steel is not suitable for the chuck body, jaws, slider and wedge because they require case-hardening. Perhaps exception to the body is possible though a good quality steel is essential, but completely case-hardening the slide and the angle of the wedge is obviously necessary. Again, though the jaws only hold comparatively soft brass, repeated clamping will cause the serrations to burr over and render them much less effective, thus the serrated surfaces are case-hardened.

Two-jaw chucks of this type have a variety of uses—one particular operation is the polishing of parts on a lathe or the rectification of threads when the latter are bruised through mishandling in the workshop, but in most cases the serrated jaw would tend to damage finished surfaces and the soft flat type of chuck jaw is preferable.

Bulk Handling of Powders—an American Method

Much loss of material and time arises in many industries through the handling of powders in bags or other vulnerable containers. Cement —either Portland or aluminous—is an example of a vulnerable product in a vulnerable container, a 1 cwt bag; a few minutes in the rain, or a splash from a hose pipe, makes the product useless. Loss of time arises in numerous industries because powdered materials used are in bags; the maker of the materials has the job of bagging and weighing them, while the user has the task of stacking them and then bringing them into process, one by one. Invariably he does not get all the material he has paid for, because some is left clinging to the bag. If the bags are of paper, he has to get rid of them; other bags have to be counted and returned. Some time ago the Americans investigated this time-consuming bag business to see how far it could be eliminated from routine industrial jobs, and what could be used to replace it. They finally hit upon the idea of rectangular, hermetically sealed containers, or bins, and a company—Tote System. Inc., of Beatrice, Nebraska—was formed to produce them. These bins immediately appealed to a wide range of manufacturers who used powdered materials in their business. Briefly, the Tote system comprises a number of bins, normally of aluminium but may be of steel for heavy products (Fig. 1) which, in some applications are all that is required. These bins have four short stout legs to raise them a few inches from the ground, so enabling a fork truck (Fig. 2) to get underneath. Their shape permits them to be carried in any flat-bottomed conveyance, road or rail truck, barge, etc. It is, therefore, an easy matter for these to be sent to the maker of the powdered product, filled, sealed and returned to the user.

The Ford Motor Company, Michigan

Fig. 1.—Steel Tote bins in a Ford powder metallurgy plant

Tote System, Inc.

Fig. 2.—Loading Tote bins on to road truck with the aid of a Baker industrial truck

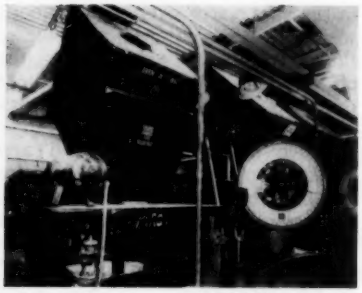
Employing rectangular bins, the user's warehouse will hold more product than it would in bags, for the bins can be tiered when required. A further advantage is that any bin can be used as a feed hopper and so become, temporarily, part of the plant. This is done by the use of Tote

The Calgon Company, Michigan

Fig. 3.—Hydraulic power is used for tilting and discharging Tote bins

Van Leer Chocolate Company, Jersey City

Fig. 4.—A small electric crane or hoist may be used for tilting the Tote bin, which latter is held firmly on the tilt unit



The Ford Motor Company

Fig. 5.—Tote bins on Tote tilts discharging metal powders at the Ford powder metallurgy plant; gaskets are used in connecting bin to the plant to give dust-free flow-out

The Ford Motor Company

Fig. 6.—Ford metal powder blending and compacting section. Tote hoppers on balcony, far end, supplying chutes which feed the presses, left and right; the blender is the conical-bottomed vessel, right rear. After compacting, the products are sintered and machined to yield the finished components

tilts, a tilt being a mechanism for holding a loaded bin firmly and tilting, or up-ending, it, to discharge at a predetermined rate. The necessary power for tilting the bin may be obtained by using small hydraulic jacks (Fig. 3), or a small overhead, electrically-operated, crane with suspended switch (Fig. 4). The empty bin is then ready for its return journey, and it is replaced by a full one. The number of bins employed by one concern varies with the size of the organization and the nature of the processes; some get by very well with six bins, others require several hundred. This system, simple as it is, eliminates the bagging of the product and the loss of material and time associated with bagging. As the bins are impervious to the weather and other external conditions, the quality of the product is maintained. A large number of plants now use the system and the mention of one or two applications will illustrate their uses.

Calgon, a water-softening and scale-removing product which has increased in production in recent years, is made by the Calgon Company, a division of Hagan Chemicals & Controls, Inc. In 1956 a new plant for its production was started up at Rockwood, Michigan, using the Tote system of handling materials. At this plant the bins hold 5000 lb of phosphates, which is the equivalent of 50–100 lb paper bags as previously used; as each paper bag cost the equivalent of one shilling, fifty shillings are saved every time a bin is filled. The loaded bins discharge their entire contents, but with bags, each one retained a few ounces of the hygroscopic product; this could not be easily dislodged without getting paper into the product. There is also a saving in storage space amounting to about 60%, because the bins can be tiered, but the tiering of bags is limited by the weight carried by the bottom layer. The Calgon plant uses 140 Tote bins, and the saving in manpower as compared with handling the product in bags amounts to 87%.

The new powder metallurgy plant of the Ford Motor Company, at Rawsonville, Michigan, affords an example of the use of steel Tote bins in place of the more widely used aluminium units. As metal powders are the heaviest industrial powders in use, the bins had to be of steel for this particular application. Ford uses at this plant alone 123 bins, each of 6000 lb capacity, as shipping, storage and discharge containers; in addition, there are 36 modified bins which are used solely inside the plant as hoppers. A series of tilts discharge the bin contents containing different varieties of metal powder into a screw conveyor, from which it passes in succession to a vibrator, another conveyor, shaker screen to a blender. The discharge of the different powders from the bins on the tilts is carefully and automatically controlled to give the desired proportions to the blender. (Fig. 5). From the blender the modified bins or hoppers take over the task of conveying the powder and these units are kept always within the plant. They are loaded from the blender, taken to the balcony above, where they serve as feed hoppers supplying the chutes to the compacting or briquetting presses (Fig. 6). With the coming of mass production methods for fabricating by powder metallurgy the many components of a modern automobile it was essential to find an efficient method of handling accurately and quickly the various mixes of metallic powder needed for the compacts. The Tote system accomplishes this precisely and at the same time prevents leakage of metallic dust to contaminate the working atmosphere and foul delicate instruments. Due to automation, it is possible at this plant to handle as much as 15 tons of metal powders in one 8-hour shift. Normally, the full processing of a batch, from discharge by the bins on the tilts to the production of the compacts in the presses occupies a little less than three hours.

Is Payment by Results Out of Date?

Mr. Donald's forthright and pungent remarks in the September issue were refreshingly direct and leave no doubt in the reader's mind as to what Mr. Donald thinks about payment by results as a means of increasing the productivity of the manual worker. Let us examine a little closer what he has said.

A very great deal has been written

in the past ten or twelve years about schemes which aim to remunerate the operator in proportion to the effort which he gives. The tremendous expansion of the use of work study techniques to improve the effective employment of land and buildings, materials, plant and equipment and human labour has resulted, *inter alia*, in the provision of reliable data on which sound payment by result schemes can be based; and it is the application of work study which has brought about an enlightened appreciation of managements' responsibilities to the community at large, to those whom they employ, and to those by whom they are employed.

Mr. Donald appears to suggest that as long as pieceworking is applied, management will automatically be kept on its toes by the workers in the matter of the provision of efficient tools and good working conditions. It is submitted that this is not necessarily so, and in any case is not the correct way for management to discharge its responsibilities, because it is not sufficiently objective. Improvements brought about by pressure from beneath are too often temporary palliatives, applied hastily to avoid serious unrest or hold-up in production.

Secondly he puts his confidence fairly and squarely in a straight piecework system and then goes on to castigate the variety of premium bonus, etc., systems which have been evolved over the years. Many supervisors will agree that complicated bonus schemes not clearly understood by the worker often result in a feeling of frustration or suspicion being engendered, or in the payment of a bonus for little or no extra effort. But is there any guarantee that payment by the piece cannot similarly be productive of argument and trouble? Mr. Donald's conception of the ideal ratefixer conjures up the vision of a superman, who by some infallible process, always arrives at the right price for the job, acceptable to both management and men. This writer has yet to meet him. And what happens when the work content of a job, such as maintenance work, varies to such an extent as to make the fixing of a *price* virtually impossible if it is to be fair to both sides under all circumstances of working.

The last remark of Mr. Donald's to which reference may also be made is his quote from a managerial pronouncement that ". . . the good manager should be able to obtain—from an alert and co-operative work force—additional effort in time of difficulty, even if the operatives do not get extra cash". This managerial view is dismissed by Mr Donald in the words "What nonsense!" Is it? In certain circumstances and under certain conditions it is submitted that it is not nonsense.

If we start from the premise that management is responsible for making sure that the best use is made of all the material and human resources at its disposal, then it follows that it is the duty of management to reduce the amount of ineffective time due to its own shortcomings and also the ineffective time within the control of the worker. The basic work content of a job can only be determined after the best available means of performing it have been established by defining the method after a close study of existing practices has revealed where ineffective time can be eliminated. Not until *all* ineffective time has been eliminated, whatever its source, should the time for a specific task be published to the operators, several of whom should have been timed according to the principles of work measurement before an allowed or standard time is determined. Payment may then be made on a basis of the number of standard work units produced by the worker per shift and there is no question of the "price" being wrong, which fact eliminates one of the biggest bones of contention between management and men.

"Speed-conscious incentive workers" mentioned by Mr. Donald are, it is suggested, few in number. The widely held view that a manual worker can work faster or slower according to his choice is only true to a point. Most people who are thoroughly accustomed to a job have a certain pace at which they work best and will feel uncomfortable if they work much faster or much slower. The worker can save time, and can be helped most effectively by management to save time, by reducing the time when he is *not* working at all, and there is no doubt that an equitable scheme of payment by results will assist to this end, but it is not necessarily payment by the piece which will bring about the desired result.

Furthermore, a scheme of payment by results based on the principles of method study followed by work measurement, provides management with labour control data which a straight piece work system can never do. It also provides the worker with a ready means of calculating his output, and therefore his earnings, however complicated the wage structure of the grade or industry in which he works. Loose piece rates, with all the evils to which they can give rise, are also eliminated by a scheme based on Work Measurement which can be applied equally well to Maintenance Work which has a varying work content.

Because management has had to put its own house in order before the introduction of a bonus scheme based on the principles of work study, a satisfactory management-worker relationship has been established which will stand the employer in very good stead when, in order to get the benefit from reduced administration costs, he wishes to abandon incentive bonus as such and move to the high task, high pay principle successfully introduced by a number of firms in various parts of the world. It is in these circumstances that a *good* manager can get extra output without necessarily expending extra cash in times of difficulty.

The reader who has been patient enough to read so far will have realized that there is really only one point at issue between Mr. Donald and the writer; the former regards straight piece work as the answer to increased productivity and the best in the long run for employer and employed; the present writer, on the other hand, maintains that an incentive bonus scheme soundly based on the results of a work study investigation is more equitable to everybody concerned and that it is most certainly of more use to the employer in the discharge of his managerial functions.—**W.G.F.T.**

Prevention of Hot Cracking in Welding

Hot cracking can take place in weld metal which is still at a high temperature—in fact very soon after the weld metal has solidified. The metal is very weak at this stage, and under certain conditions the contraction stresses set up as the joint cools are sufficient to cause cracking. The most common circumstances in which this occurs are conditions of high restraint—i.e., when the thickness of the plate being welded, and the design of the joint, do not allow any movement as the work cools.

The first precaution to take against hot cracking is to ensure that the weld is strong enough: a slight increase in throat thickness is often all that is necessary to cure this fault, making the weld strong enough to withstand contraction stresses. It is important, too, to choose a welding sequence which will minimise stress—the "step-back" and "planned wandering" methods are examples.

An example of insufficient strength in welds is the very common occurrence of "crater cracking". This is usually caused by breaking the arc too suddenly, leaving very thin metal in the crater. While the weld is capable of withstanding contraction stresses where it is of full section, the thin crater metal has insufficient strength, and cracks. Care should therefore be taken to fill craters sufficiently to counteract this.

Plate fit-up can also influence hot cracking and as good a fit-up as is possible should be made.

The choice of electrode is important. Although the use of an electrode which will give good mechanical properties is always desirable, other characteristics may be equally essential in the prevention of hot cracking. Such features as depth of penetration and weld contour must be considered as they affect the effective throat thickness.

When welding mild steel the carbon and sulphur contents of the parent metal can have a considerable bearing on any tendency towards hot cracking. This is because part of the parent metal is melted, and the deposited weld metal can thus pick up sulphur and carbon. An increase in the carbon content may accentuate segregational effects and increase the tendency towards hot cracking.

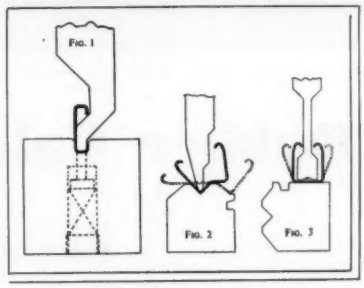
The small amount of sulphur normally present in steel exists as small globules of high melting point manganese sulphide evenly distributed throughout the metal. If, however, there is insufficient manganese to form this compound the sulphur combines with the iron as iron sulphide. This has a lower melting point than the steel and as a result there is a period during solidification when the solid steel grains are surrounded by a film of still liquid iron-sulphide. In this condition the material is understandably very weak and unable to resist contraction stress. These effects may be counteracted to a large extent by the use of electrodes having a basic flux which has a cleansing action on the molten pool of metal.

One of the most frequent occurrences of hot cracking is in fully austenitic weld metal, particularly in multi-pass welding on heavy sections. This is one of the inherent characteristics of this type of metal, which is customarily prevented by the use of an electrode giving about 5% or more of ferrite in the austenitic structure; there are a large number of electrodes of this type. Where ferrite is not admissible because of service considerations, such as the need for stability at high temperatures, Quasi-Arc's Chromoid No. 5 can be used. This electrode contains less than ½% ferrite, and was specially designed for all-position welding of stressed components in heat and corrosion-resisting steels, for joining dissimilar steels, and for welding stainless clad steels.

In welding austenitic steels particular care should be taken to fill the crater properly, and to ensure that the weld metal does not get too hot. Narrow runs should be deposited and wide weaves avoided and as small a molten pool as possible should be maintained. Speed of travel should be as high as possible, since this is consistent with good welding.

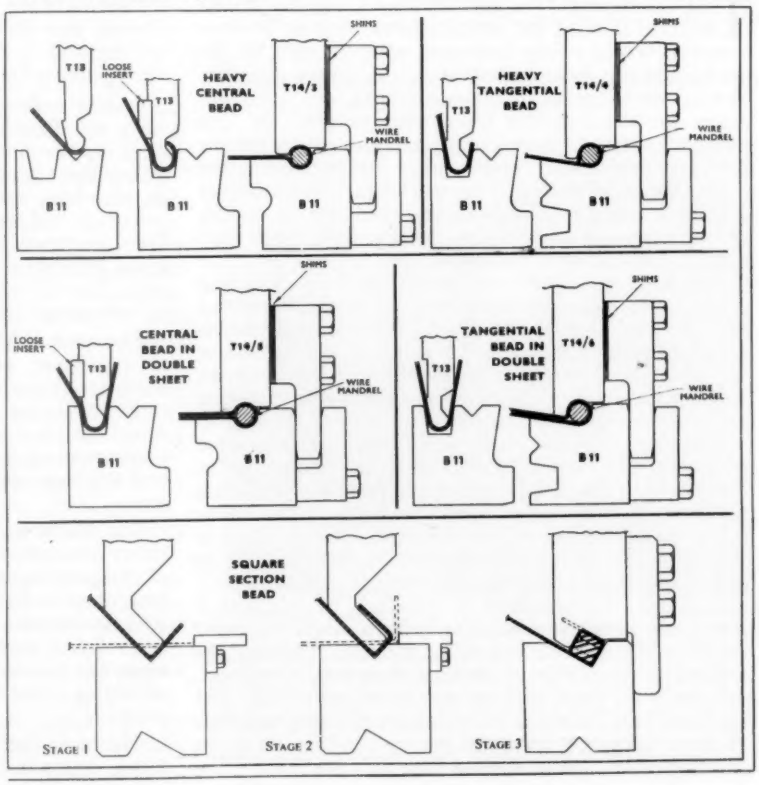
Press Brake Tooling for Beaded Sections

Reproduced here are sample illustrations taken from the Bronx press brake tool manual which has recently been produced by The Bronx Engineering Company Limited, Lye, Worcs. It is to assist users in making the best choice of the many tools available. Illustrations are for the most part self explanatory —Figs. 1, 2 and 3, tooling for small channel runner sections. Special care is required in designing return flange tools to combat cumulative spring back from the bends. Fig. 4 shows bead forming tools.

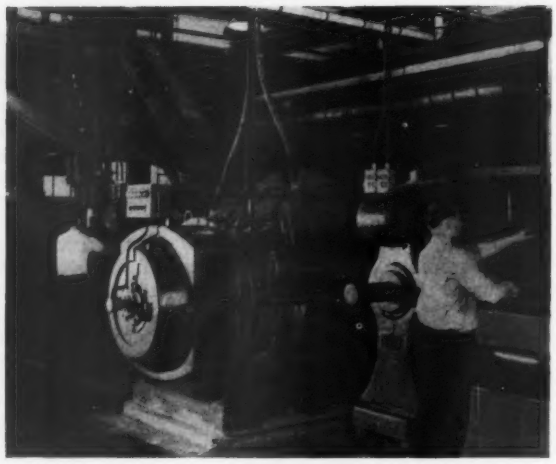


Figs. 1, 2 and 3.—Forming channel runner sections

Fig. 4 (below).—Bead forming tools for heavy gauge material



Banbury mixer driven by 1500 hp, 743 rpm, closed-air circuit slipring induction motor



Two rubber mills driven through right-angle bevel gears by 400 hp, 743 rpm protected-type slipring induction motor

Rubber Calendering

Electrically driven train of automatic machinery

THE Goodyear Tyre and Rubber Company (Great Britain) Limited has recently installed in its Wolverhampton Works a fully automatic calender train for the production of rubber coated fabric used in the manufacture of tyres, footwear, conveyor belts, etc. Electrical drives for the calender train were supplied by The English Electric Company, together with drives for the Banbury mixer and rubber mills for processing the rubber before it is used in the calenders. The Goodyear Tyre and Rubber Company has installed a similar calender train in its Glasgow Works, once again with English Electric drive equipment.

The Banbury mixer—for mixing and compounding rubber stock, the main ingredients of which are rubber, carbon black, sulphur and other chemicals—was manufactured by David Bridge & Co. Limited, and consists of two rotors on which cams are formed to make an interrupted spiral. A slight speed difference is provided between the two rotors to ensure constant inter-mixing.

A 1500 hp, 743 rpm, 6600 volt slipring induction motor providing high starting and accelerating torques drives the Banbury mixer. Because of the presence of carbon black in the atmosphere special precautions had to be taken in the design of this machine. Carbon black is noted for the extreme fineness of its particles and its presence on the windings, sliprings or brushgear is undesirable. This problem is overcome by adopting a closed air circuit arrangement, with a single water/air cooler mounted at the side of the machine. The sliprings are outside the cooling air circuit and are totally enclosed. All machined joint surfaces are fitted with seals, and shaft seals are provided on the pedestal sleeve bearings. To stop particles entering the machine by 'breathing' on shutting down, special filtered breathers are fitted.

Control of the motor is from the operator's platform. Control gear also provides for occasional reversing and inching and is located in a separate room where the atmosphere is free from carbon black.

Rubber mills are used for sheeting (ironing out stock from the Banbury mixer); breaking (reducing crude stock to the required plasticity); mixing rubber stock with other ingredients; warming cold stock for feeding to calenders; cracking (shearing and tearing reclaimed material); and washing and cleaning crude rubber stock. They are open roll mills comprising two rolls with a speed differential between the rolls to provide a friction ratio. The roll surfaces may be smooth, spirally grooved or corrugated depending on the duty.

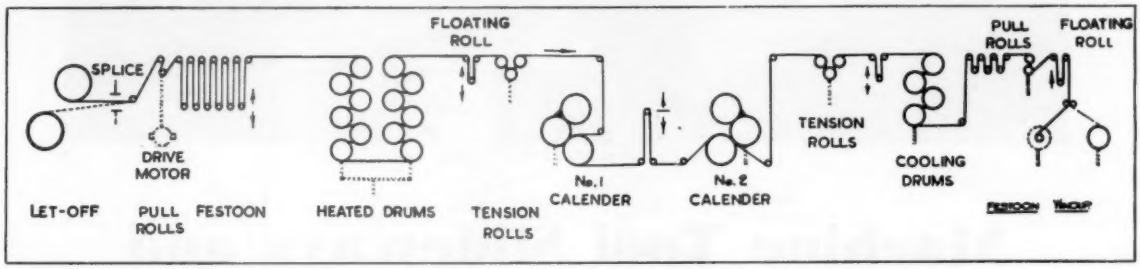
The seven 400 hp English Electric motors driving mills at Goodyear are protected-type slipring induction machines giving high starting and pull-out torques. These rubber mills are situated adjacent to the calender train where the air is relatively free from carbon black, but as a safeguard against carbon black accumulation, windings and sliprings are blown out regularly with compressed air.

The operators work close to the rolls and although all safety precautions are taken the motors must be capable of stopping rapidly. The motors have low rotor inertias, and 'plug' braking is used to bring them to rest quickly. Roll travel with emergency stopping by 'plugging' is about $\frac{1}{8}$ revolution measured on the front roll. The rotor slip-rings are mounted within the endshield bearings, thus providing a free shaft end to drive a zero-speed plugging switch.

The basic function of the calender machine is to coat fabric with a uniform film of rubber. The calender train

The calender train from the let-off end. The let-off pull rolls motor can be seen in the top left of the picture and the drying drums motor in the middle left

Auxiliary and exciter sets for calender train, with d.c. main and auxiliary control cubicle



Continuous double rubber coating calender train

also processes and conditions the cord fabric entering the machine and cools it after calendering. Storage festoons at both ends of the train act as reservoirs during changing of rolls of fabric. Two sets of separately driven calender roll groups are provided to produce fabric that is coated on both sides. The calender train was also supplied by David Bridge & Co. Limited.

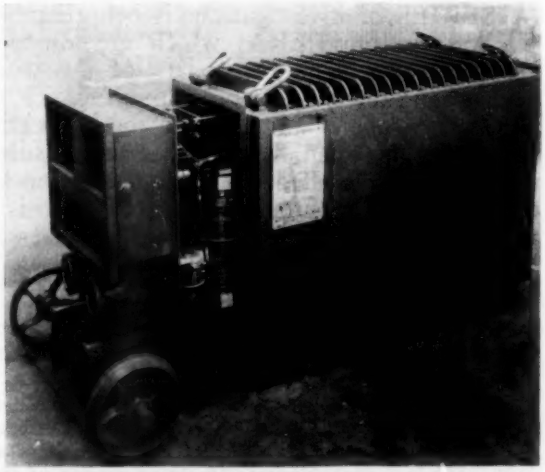
Each set of calender rolls is driven by a 300 hp, 1200 rpm. 500 volt d.c. motor with low rotor inertia supplied from a Ward Leonard motor-generator set comprising two d.c. generators driven by a 700 hp, 1000 rpm, 6600 volt synchronous motor. Seven other d.c. motors are used to drive the various auxiliary sections.

The extensive electrical control equipment comprising all the necessary contactors, relays, magnetic amplifiers, rheostats, limit switches, etc., is situated in a control room together with the two low-voltage auxiliary motor-generator sets providing variable voltage supplies for the auxiliary motors in the calender train. These motor-generator sets are driven by 415 volt, 3 phase, squirrel cage induction motors.

The control scheme incorporates magnetic amplifiers to maintain accurate speed holding on the two calender motors and to provide adjustable control of fabric calendering tension. Normal contactor controls ensure correct sequence of operation for the auxiliary section motors.

The calender train is stopped very rapidly in an emergency by two-stage electrical braking, both dynamic and regenerative.

The operator's controls for the train are mounted on a desk located between the two calenders.



NITROGEN-FILLED MINING TRANSFORMER.—A Metropolitan-Vickers 300-kVA nitrogen-filled Class H insulated mining transformer with the core and windings partially withdrawn to show the internal construction. The air-filled chambers on the left, shown with covers removed, are of flameproof construction and house the H.V. tapping terminals and links, the neutral link and fuses and the L.V. line terminals. The other end of the tank is attached to the end frames of the core and windings before tanking and both ends are welded to the tank after the core and windings have been fully inserted. Two further rollers are then mounted on the other end, where another air-filled chamber of flameproof construction houses the pressure switch, the earth leakage test switch terminals and the high voltage line terminals. The makers are Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17

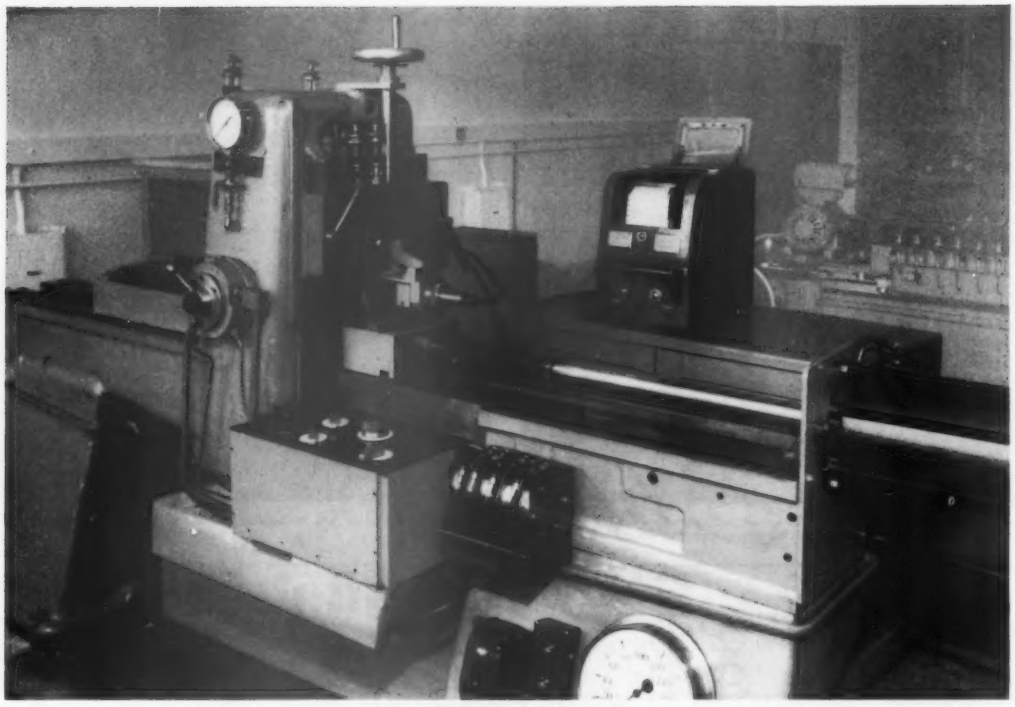


Fig. 1.—PERA friction testing machine

Machine Tool Slideways and Lubrication

A SERIES of investigations is being carried out by the Production Engineering Research Association (PERA) which are aimed at providing design data for the slideways of machine tools. The first part* of the work was carried out with the general object of determining the effect of type of surface (i.e. hand scraped, periphery ground and cup ground), lubricant viscocity and load on the lubrication conditions (i.e. boundary mixed or fluid film) that occur between flat surfaces under substantially parallel sliding conditions. Of special interest were the effects of these factors on kinetic and static friction, stick-slip and the onset of full fluid film lubrication. The work is summarized here by T. M. Birchall, B.Sc. and A. I. W. Moore, Senior Research Engineers, Production Engineering Research Association.

Terminology

THE terms boundary, mixed and fluid film lubrication conditions are taken to have the following meanings.

Fluid film or hydrodynamic conditions:

When the sliding surfaces are completely separated by a lubricant film of appreciable thickness. Under these conditions the resistance to motion is due entirely to the viscosity of the lubricant film and no wear of the solid surfaces takes place.

Boundary conditions:

When the sliding surfaces are separated by lubricant films of only molecular dimensions. Under these conditions the friction is influenced by the nature of the underlying surface as well as by the chemical constitution of the lubricant. The bulk viscosity plays little or no part in the frictional behaviour.

Mixed conditions:

When there are localized areas of fluid film lubrication with the remainder of the bearing area under boundary conditions.

Slideways for machine tools may be classified into two main groups, those which are associated with cutting tool feed rates and operate in the low speed range from about 0·1 in./min to 50 in./min and those which are associated with cutting speeds and operate at relatively high speeds of 150 ft/min to 500 ft/min or more. The

* Copies of the full report can be purchased at a cost of £1.1s.0d. from the Secretary, PERA, Melton Mowbray, Leics.

first group includes sliding units for milling and horizontal boring machine tables, planer and vertical boring mill heads, lathe saddles and grinding machine wheel heads. The second group includes planing machine tables, shaping machine rams and vertical boring mill tables. Certain types of sliding system fall outside these groups, since tables operating at slow feeds are often provided with quick traverse mechanisms, and grinding machine tables, for instance, operate at speeds up to 100 ft/min. In addition, very low sliding speeds are now frequently necessary in the operation of some forms of contouring and automatic positioning mechanisms.

The loads on slideways arise from the weight of the sliding unit and the workpiece, if this is carried on the sliding member, together with the forces set up by the cutting action. In some cases the weight of the table and work may be considerable compared with the forces set up by the cutting action and in other cases the cutting forces may contribute the greater part of the load.

The desirable properties of machine tool slideways are freedom from wear, scoring and seizure; good friction characteristics including absence of stick-slip; accuracy of straight line motion and adequate load carrying capacity. Several schemes have been introduced with the object of improving some of these features and include rolling bearing slides, hydrostatic slides, plastic materials and various types of lubricant.

The majority of machine tool slideways in this country consist of a cast iron on cast iron combination. This allows the simple and economical system of using a relatively inexpensive constructional material to form both the structure of the machine and the surfaces of the slideways. Despite the fact that the operating conditions for various types of machine are very different, the basic form and design of the majority of machine tool slideways are similar; two nominally parallel plane surfaces are arranged to slide together and provision is made for introducing a lubricant. A number of such surfaces may be combined in various ways to provide the different slide arrangements such as vee and flat, double vee and dovetail. The conventional methods of preparing the cast iron sliding surfaces are by scraping or grinding, the choice of method quite often depending on production rather than functional requirements. The loading on the slideways is usually expressed in terms of the total load divided by the bearing area, and common values range from 10 psi to 80 psi. However, owing to asymmetrical loading conditions and divergencies from true plane surfaces due to machining errors and deflexions, it is highly probable that the load per unit area reaches much higher values at certain points on the slideways.

Although much fundamental work has been done on problems of friction and lubrication, little is directly applicable to machine tool slideways. The work described here was designed to form a foundation for further studies of the behaviour of machine tool slideways. Conditions obtaining in the test equipment simulated as closely as possible the conditions in part of a typical machine tool slideways and yet permitted much greater control of such factors as geometrical accuracy, distribution of load and lubricant supply. The results obtained elucidate the fundamental lubrication mechanism involved over contiguous parts of the sliding surfaces.

The load on machine tool slideways is not uniformly distributed over the sliding surfaces and will depend on the particular element of the contact area which is under consideration. The resultant friction force on the machine tool slideway thus involves the summation of the contributions of individual elements. The form of the coefficient of friction/sliding velocity relationship is altered on account of this. In place of a steeply descending curve, a much shallower curve is to be expected since the averaging process tends to obscure the basic relationship between coefficient of friction and sliding velocity. Part of the utility of this investigation is that the underlying effects are sharply defined, whereas with larger scale equipment they tend to be masked due to this averaging process.

A variety of factors may affect the friction characteristics of sliding surfaces, for example, scale effects of various types including that just discussed; questions relating to the supply of lubricant; rubbing effects due to particles entrapped between the mating surfaces; and many other matters peculiar to actual machine tool slideways. Further work is now in progress to investigate some of these additional effects.

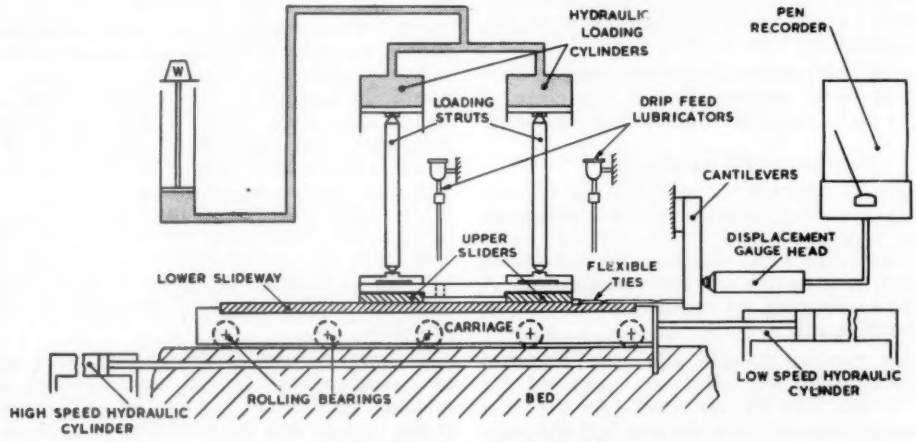


Fig. 2.—Schematic arrangement of machine

Fig. 3.—Lower test slideway

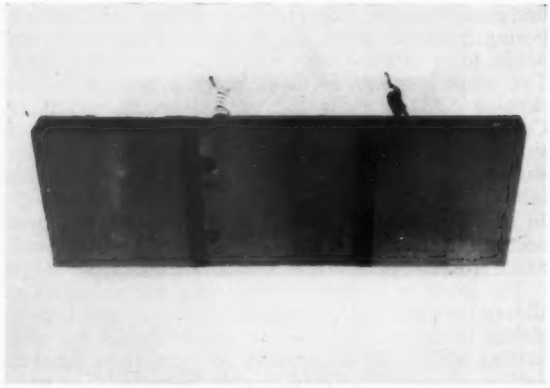


Fig. 4.—Upper test slideway

The majority of machine tools have a cast iron on cast iron slideway combination; cast iron was selected therefore as the material for the test slides. Three pairs of sliding surfaces were prepared in three different ways, namely, by hand scraping, periphery grinding and cup grinding. Numerical values of the surface finish of each test surface are given in Table I.

So that viscosity effects would not be confused with boundary lubrication effects, the lubricants used were straight mineral oils containing no boundary additives. The three lubricants used had nominal viscosities of 100, 500 and 1,500 Redwood 1 sec at 70°F.

Two test loads of 20 psi and 50 psi were used as these were considered fairly representative of the range of loads generally encountered in machine tool slideways.

Friction testing machine

As previously mentioned, the performance of conventional machine tool slideways is probably influenced by numerous variable factors which are not easily isolated. For this reason the special equipment shown in Fig. 1 was constructed for the investigation. A schematic layout indicating the essential features of the machine is shown in Fig. 2.

The machine consists basically of a cast iron bed having horizontal slideways which are machined flat and parallel. A cast iron carriage fitted with five pairs of roller bearings runs on the horizontal bed slideways and is guided by two pairs of ball bearings which roll on vertical machined faces on each side of the bed. The carriage can be reciprocated by either of two hydraulic cylinders at velocities varying from approximately $\frac{1}{16}$ in./min to 350 in./min over a stroke of 30 in. Provision is made for measuring the velocity of the carriage, and a system of trip dogs and valves enables the carriage to be reversed or stopped at any position of its stroke.

The lower test slideway (Fig. 3) which is 30 in. long by 5 in. wide is fixed to the moving carriage. The upper slider assembly (Fig. 4) which slides on the lower slideway consists of two cast iron pads 3 in. long by $3\frac{3}{8}$ in. wide spaced 4 in. apart and secured to a steel bridge piece. Motion of the upper slider assembly is restrained by a force measuring system. Lubricant is supplied at two points in front of the leading edge of each pad of the upper slider by two drip feed lubricators.

Table I.—VALUES OF SURFACE FINISH OF SLIDING SURFACES

Slider	Direction	Surface Finish μ in. C.L.A.		
		Hand Scraped	Cup Ground	Periphery Ground
Upper	Longitudinal	22	14	4
,,	Transverse	21	6	7
Lower	Longitudinal	24	14	4
,,	Transverse	25	12	8

In order to reduce effects due to ambient temperature changes to a minimum, the equipment was installed in a room in which the temperature could be controlled to within 4°F under most conditions.

The load is applied to the centre of each of the two pads of the upper slider through ball ended struts by two hydraulic piston and cylinder assemblies. Oil under pressure is supplied to these cylinders from a hydraulic accumulator which ensures a uniform pressure free from pulsations. The required oil pressure is obtained by placing suitable dead weights on the accumulator piston. This arrangement permits a constant load to be applied to the sliding surfaces even in the event of any movement of the upper slider in the vertical direction. Oil pressure, and hence the load applied to the slideway surfaces, is determined by means of a pressure gauge coupled to the hydraulic system in close proximity to the loading cylinders.

This arrangement employing a two pad upper slider, each independently loaded, was contrived in order to minimise the possibility of a "tilted-pad" effect occurring. It was thought that the possibility would have been very real if a single-pad slider had been used.

The friction force is measured by arranging the force to be resisted by a pair of cantilevers whose resulting deflexion is recorded and electrically amplified (see Fig. 2). The upper sliding surface is connected by means of flexible ties, one on each side of the slider, to the extremities of two relatively stiff cantilevers. The flexures are designed to impose no constraint on the slider in a vertical direction and are positioned so that the restraining force is in the plane of sliding. The two cantilevers are connected by a cross beam, the centre of which is in contact with the stylus of the displacement gauge head. Thus, as the lower sliding surface is traversed, the friction force tending to carry the upper slider with it deflects the cantilevers and hence the stylus of the gauge head. The resultant signal from the gauge head is amplified and fed to the Talymin pen recorder.

The friction force measuring system was calibrated by applying incremental horizontal forces to the pair of cantilevers by means of weights and pulleys. The resulting

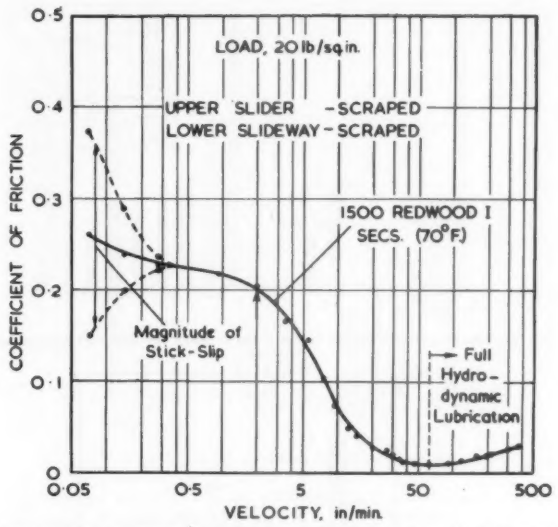


Fig. 5.—Typical curve showing variation of coefficient of friction with sliding speed

deflexion of the cantilevers induced deflexion of the pen on the pen recorder, the scale of which was then calibrated in pounds. Two ranges were available on the pen recorder which corresponded to friction forces of 0 to 450 lb and 0 to 90 lb. On the former range, the friction force could be read to an accuracy of $\pm$ 1 lb and on the more sensitive range to $\pm \frac{1}{4}$ lb.

In the course of the investigation, variations in coefficient of friction with sliding speed were determined over a range of speeds from $\frac{1}{16}$ in./min to 350 in./min. A typical curve plotted on logarithmic-linear scales is shown in Fig. 5.

The curve commences at low sliding speeds with a divided portion represented by broken lines which indicate the magnitude (in terms of coefficient of friction) of the stick-slip motion. As the sliding speed increases, the coefficient of friction decreases as a greater proportion of the load is supported by partial hydrodynamic films. Eventually a point is reached where the coefficient of friction has a minimum value and under these conditions the sliding surfaces are completely separated by a lubricant film whose thickness is of the order of magnitude of the surface irregularities of the sliding members. At sliding speeds above this point, the coefficient of friction increases according to the laws of hydrodynamics.

It was noted during the tests that as the sliding speed increased, the amplitude of stick-slip decreased until it could no longer be recorded with the instruments used. This point is shown on the curve where the broken lines converge into the single curve. At speeds beyond this point, however, stick-slip was in most cases still detectable by the presence of a vibration in the sliding unit. The point at which stick-slip was no longer detected is indicated on the curve in Fig. 5 by an arrow.

Fifty-four curves similar to that shown in Fig. 5 were obtained for every possible combination of the three lower slideway surfaces, three upper slider surfaces, three lubricant viscosities and two loads. In order to present the results in a manner which would enable the main effects to be readily studied, they were statistically analysed and a series of average curves was constructed. In the construction of these average curves, stick-slip

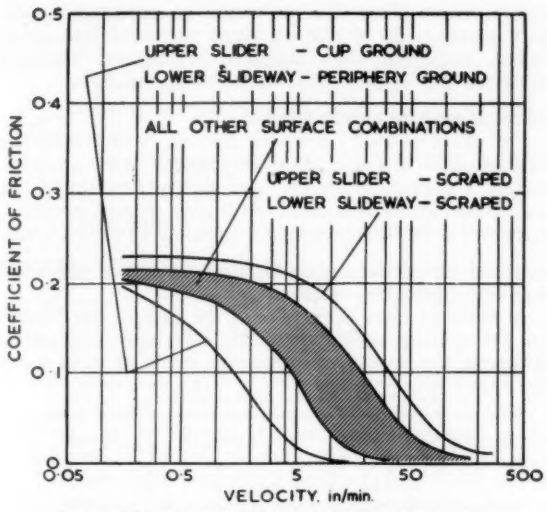


Fig. 6.—Effect of various surface combinations on kinetic friction

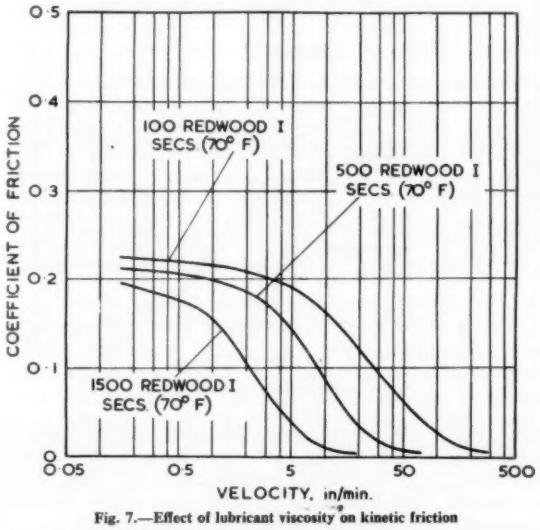


Fig. 7.—Effect of lubricant viscosity on kinetic friction

was neglected, the mean of the stick-slip envelope being taken as the continuation of the kinetic friction curve. A separate analysis was carried out to determine the effects of the variable factors on stick-slip.

Effect of type of surface on kinetic friction

The average curves depicting the effects of the various sliding surface combinations on kinetic friction are shown in Fig. 6. At all sliding speeds, up to that at which full fluid lubrication occurred, the coefficient of kinetic friction was highest with the scraped surface combination.

The cup ground upper slider with a periphery ground lower slideway exhibited a lower coefficient of kinetic friction than the other surface combinations through the region of boundary and mixed lubrication.

The remaining surface combinations gave rise to intermediate effects and are all contained within the shaded area in Fig. 6.

Effect of lubricant viscosity on kinetic friction

The average curves depicting the effect of lubricant viscosity on the friction/speed relationship are given in

Fig. 7. These show that, as would be expected, for all sliding speeds up to that at which full fluid film lubrication occurred, the lubricant of highest viscosity exhibited the lowest coefficient of kinetic friction.

Effect of load on kinetic friction

The effect of load on kinetic friction is shown by the average curve in Fig. 8. At sliding speeds below approximately 7 in./min the lower load (20 psi) exhibited the higher coefficient of friction. At higher speeds, however, there was little difference in the friction for the two loads.

Effect of various factors on the sliding speed at which full fluid film lubrication occurred

In order to show the effects of the various test factors on the sliding speed at which full fluid lubrication occurred, the results are presented in the form of a bar

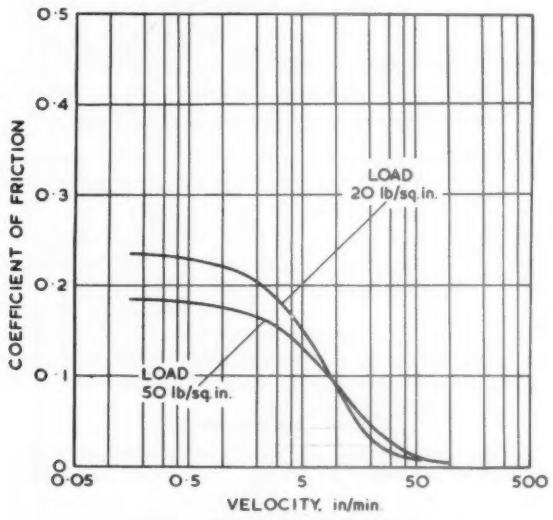


Fig. 8.—Effect of load on kinetic friction

chart, Fig. 9. The most favourable conditions for complete separation of the sliding surfaces were a high viscosity lubricant, low load and ground surfaces. The worst conditions from this point of view were a low viscosity lubricant, high load and scraped sliding surfaces.

Effect of various factors on static friction

The results indicated that the only factors which had a marked effect on the coefficient of static friction were lubricant viscosity and type of surface of upper slider. The type of surface of the lower slideway did not appear to affect static friction. The effects of the two factors are shown in Fig. 10 which indicates that the worst conditions from a static friction aspect were a scraped slider and low viscosity lubricant.

Effect of various factors on stick-slip

The effects of various factors on the speed range over which stick-slip was detected are shown in the bar chart Fig. 11. This chart indicates that the worst conditions from the point of view of persistence of stick-slip were a low viscosity lubricant, high load and scraped sliding surfaces.

The factors which affected the magnitude of stick-slip (i.e. the difference between the friction at stick and the friction at slip) over a limited range of sliding speeds are shown in Fig. 12. The curves show that at a sliding

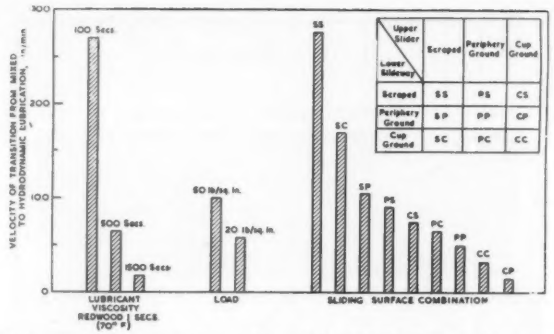


Fig. 9.—Effect of various factors on the speed at which full fluid film lubrication occurred

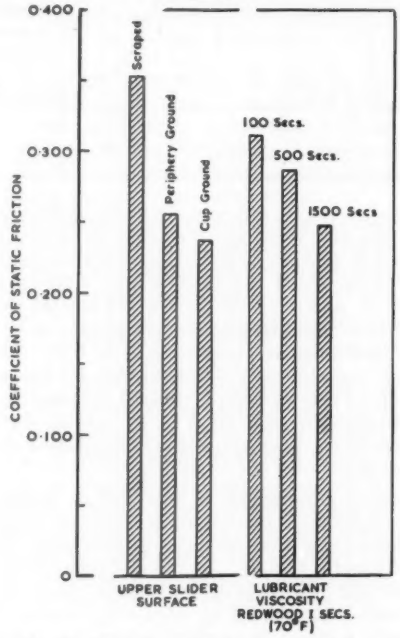


Fig. 10.—Effect of various factors on static friction

speed of 0·1 in. per min, the magnitude of stick-slip was influenced both by the load and the type of surface of the upper slider. At this speed the high load and scraped slider caused the maximum severity of stick-slip. The effect of the slider surface became less pronounced with increased sliding speed until at a speed of 0·3 in. per min only the load had a marked effect on the magnitude of stick-slip.

Remarks

Although a considerable amount of data has already been obtained, the investigation should not be considered in any way complete. Much remains to be done to provide a more complete understanding of the mechanism of lubrication between substantially parallel sliding surfaces. As previously mentioned, many additional factors may affect the performance of a machine tool slideway in practice such as various scale effects, lubricant supply, effects of foreign particles in the lubricant and standing time. Thus, although the results of this investigation showed that in general the frictional characteristics of the ground surfaces were superior to those of the scraped surfaces, extraneous factors related to

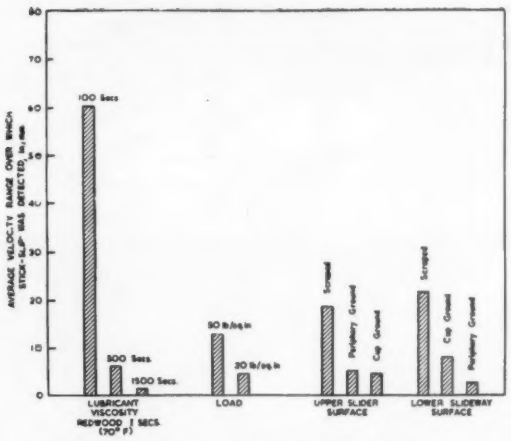


Fig. 11.—Effect of various factors on stick-slip

particular conditions of service may sometimes favour the use of scraped surfaces.

Where such conditions exist, possible reasons for the better results frequently claimed for scraped surfaces may be:

(1) In some cases where the distribution of lubricant is inadequate, scraped surfaces may provide flow paths

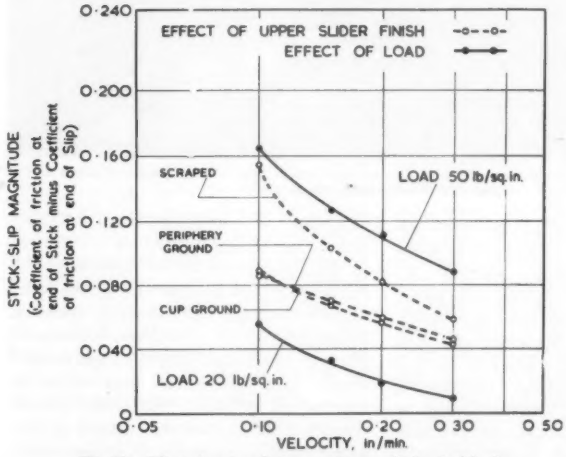

EFFECT OF UPPER SLIDER FINISH
EFFECT OF LOAD
SCRAPED
LOAD 50 lb/sq.in.
PERIPHERY GROUND
CUP GROUND
LOAD 20 lb/sq.in.
STICK-SLIP MAGNITUDE (Coefficient of friction at end of Stick minus Coefficient of friction at end of Slip)
VELOCITY, in/min.

Fig. 12.—Effect of various factors on the magnitude of stick-slip

which allow lubricant to gain access to areas which might otherwise be starved of lubricant.

(2) Scraped surfaces can probably be prepared to a higher degree of flatness and therefore conformity, thus distributing the load on the slideway more effectively and reducing the tendency for localized regions of high loading.

(3) Foreign particles in the lubricant may be passed between scraped surfaces without causing excessive damage. If contact does occur it is probable that the damage will be confined to a localized high spot on the scraped surface. On the other hand, such a particle contacting closely mating ground surfaces would be likely to cause surface damage which would become more severe and extend over a much greater area. This is illustrated in Fig. 13.

(4) After a slideway has been at rest under load for a considerable period of time, most of the lubricant

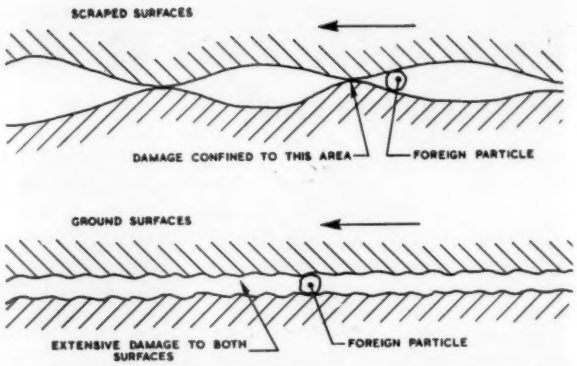


Fig. 13.—Comparisons of effects of foreign particles entrapped between a pair of scraped surfaces and a pair of ground surfaces

would be squeezed out from between ground surfaces. In the case of scraped surfaces, however, small reservoirs of oil may remain in the scraped pockets and thus provide initial lubrication of the surfaces until the normal mechanism of lubrication comes into effect.

Summary

This investigation has demonstrated the fundamental frictional behaviour of flat cast iron slides under substantially parallel sliding conditions when lubricated with an adequate supply of clean mineral oil. By making use of these results and bearing in mind the possible influence of other factors including those already mentioned, designers will be able to form some idea of the type of lubrication to be expected in a machine tool slideway under a fairly wide range of conditions.

In order to supplement the data provided by this investigation, work is continuing at PERA to study scale effects, lubricant supply and other factors on larger scale equipment which has recently been constructed. The performance of different additive type lubricants, solid lubricants such as molybdenum disulphide, and of various slideway materials including plastics, is also being examined. These investigations will provide further design data for machine tool slideways.

Phase and Continuity Indicator

A pocket-sized instrument, which provides visual signals by five neon lamps to indicate the peak voltage sequence in three-phase supply lines and also to identify broken lines, is now being produced by Tiltman Langley Limited, Redhill Aerodrome, Surrey. The whole unit is continuously rated, and three of the lamps are arranged so that if the lines under test are "live" all three lamps light up. In the event of one line being "dead" the lamp associated with that line will light up whilst the others will remain unlit. Provided that all the lines being tested are sound, phase sequence will be shown by one or other of the two remaining lamps lighting up. The instrument is fitted with flying leads terminating in insulated clips or interchangeable test probes and complete with stowage compartment, measures $3 \times 2 \times 1\frac{1}{2}$-in.

The initial instrument is priced at £5.5.0. ex-works and caters for three phase, 115/200-v, 400 cycles, a.c.—and a similar version for 400-v, 50/60 cycles is also available.

Epicyclic and Reduction Gear Production

The new W. H. Allen Sons & Company's factory at Pershore devoted entirely to gear and gear unit design and manufacture

AFTER 77 years in the fields of marine and general engineering the firm of W. H. Allen Sons & Company Limited, of Bedford, needs little introduction. Their wide range of products, which include steam and gas turbines, steam and diesel engines, condensing plant, pumps, fans, epicyclic and parallel-shaft gears, electric generators, motors and control gear are designed and produced at Queens Engineering Works, Bedford, in association with two subsidiary factories, Biddenham Works, Bedford, and Atlas Works, Pershore, Worcestershire. The latter factory which was only acquired in 1955 has now been completely modernized and equipped solely for the production of parallel-shaft type speed reduction gears and the Allen-Stoeckicht epicyclic gears, the manufacture of epicyclic gears being the result of a licence and design consultancy agreement with Herr. Dipl.-Ing. W. Stoeckicht of Munich.

The success of double-helical epicyclic gearing during the past few years has led to its increasing adoption for many applications for the transmission of a very wide range of powers at varying speed ratios. For instance W. H. Allen Sons & Company Limited are now manufacturing a large number of gear units varying from 100 to over 10,000 hp for which gears provide a very wide range of input speeds, varying from a few revolutions per minute up to 45,000 rpm.

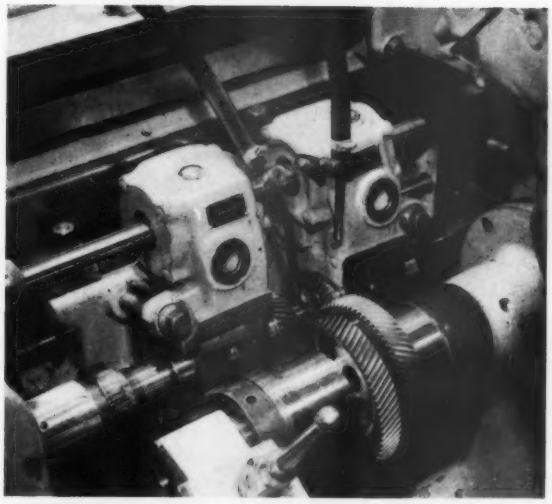
Their main advantages are the considerable savings in weight and space as compared with parallel-shaft gears, such savings being due to the fact that the transmitted load is shared between several tooth contacts. Load sharing is achieved by the provision of an annulus system which is, in itself, flexible and which is connected to the gear case or shaft by means of a double gear-tooth-type flexible coupling. In addition, in high-speed applications, the central sun wheel, which is supported by the planet wheels and has no bearings, is connected to the high-speed shaft by means of a double tooth-type coupling.

Main machine shop at Atlas Works viewed from the light machine section. Extensive use is made of pallets for the transport of all components and materials

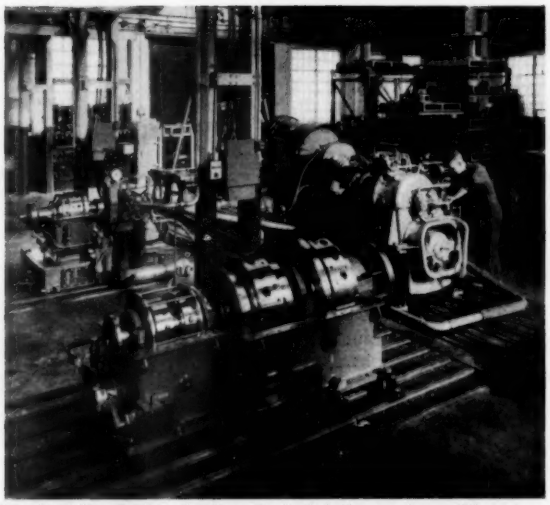
Gear units at present in production at Atlas Works are typical examples illustrating the wide variety of applications for which epicyclic gearing is now being used, and for which gear units are specially designed. The gear shown in the foreground of the test bay is a 160-hp two-speed epicyclic gear for transmitting a maximum output torque of 110,000 lb ft at a minimum speed of only 9 rpm. This gearbox is for use on a new type of mine tunnelling machine, driven by a two-speed motor, providing an input speed of 1500 or 650 rpm and the range of four output speeds obtainable is 24 or 18, 12 or 9 rpm. The two-speed gear is followed by a double-reduction gear and the gear unit has an overall ratio of just over 80:1, and this high reduction and large torque are obtained from a unit only 6 ft in length and weighing only 5½ ton. The largest annulus is 30 in. diameter. Four similar gear units are to be used on mine tunnelling machines.

Another epicyclic gear unit for use with a motor-driven boiler-feed pump is a speed-increasing gear designed for transmitting 2400 hp from the motor speed of 1500 rpm to the pump speed of 4500 rpm. A feature of this gear is the absence of main bearings; the rotating annulus assembly, which forms the low-speed shaft is connected direct to the motor shaft. The high-speed sun wheel is supported between the three planet wheels and is coupled direct to the pump shaft through a gear-tooth-type flexible coupling. This arrangement of gearing eliminates the use of external flexible couplings and offers a very compact and highly efficient gear for the duty. Other gears of this design are being manufactured for compressor and blower drives, the gear internals so designed that they will be mounted in the pedestal supporting the motor/compressor bearings.

Further interesting developments include a 3500 hp reverse/reduction gear for marine propulsion. These gear units are being developed for the Admiralty and are designed to transmit full power ahead or astern. No clutches are used in the gear, and reversing is achieved by an hydraulic-



One of the two Sykes 3C gear shaping machines specially built to W. H. Allen Sons & Company's own specifications simultaneously cutting the double helices



View of test bay, showing epicyclic gear units, including a main propulsion reverse reduction gear assembled on test beds. In the foreground is an epicyclic gear for a 160 hp mine tunnelling machine. The gear incorporates a two-speed unit and a double-reduction unit. With an input speed (from two-speed motor) 1500 or 650 rpm, the final output speeds are 24 or 18, 12 or 9 rpm

ally-operated brake. The complete gearbox is of special design, incorporating a hardened and ground vee-drive and parallel-shaft transfer gear, in addition to the epicyclic reversing reduction unit.

The main buildings of Atlas Works were originally arranged as a cruciform which has proved a most suitable shape for a gearing production establishment, with the works offices, inspection, tool stores and finished parts stores situated in the centre of the cruciform and providing an efficient control of the works. A control of temperature is achieved by means of a new airlock built at the main entrance to the works buildings, through which all raw materials are brought in, and all finished gears are despatched.

The factory is now completely re-equipped with new general-purpose machine tools to support the special gear-cutting machines transferred from Queens Works, Bedford, and, already, the manufacturing capacity at Atlas Works is adequate for producing the required increased output of all types of Allen gearing.

The arm of the cruciform running from east to west, comprises the main machine shop for general-purpose machining, while the inwards stores and despatch department are situated adjacent to the airlock previously mentioned. The heavy machines are concentrated under the main overhead crane which runs along the centre of the shop, and the lighter machine tools are installed in the side aisles where the roof height is lower. The gear parts produced on these machines are handled by electrical hoists.

Situated towards the eastern end of the cruciform are the large horizontal borers together with the 100-in. Lumsden surface grinder, which is used to surface the joint faces of all gear cases. The use of this machine obviates the need for planing and scraping operations as it is capable of a very high metal removal rate and, at the same time, gives extreme accuracy with very good surface finish. Amongst general-purpose machine tools are included two electro-magnetic Avery dynamic balancing machines which are capable of balancing components weighing up to 6000 lb.

Nearly all the machines in the main machine shop are connected to a centralized coolant supply to enable a better control to be kept on the quality of the coolant. An electric annealing furnace is installed at one end of the shop for stress relieving components between machining operations, and can handle components up to 4 cubic ft, the temperature and time cycle being automatically controlled.

The gear cutting shop is situated in the southern arm of the cruciform, in which are installed all the gear-cutting and finishing machines, together with a No. 7 Societe Genevoise jig-boring machine. The latter machine is used as a production machine for precision positioning of the holes for the planet-wheel spindles in planet carriers of epicyclic gears and other high precision boring and milling operations.

The gear-cutting machines include high-precision gear-hobbing machines, gear shapers, gear grinders and shaving machines. The largest gear-hobbing machine is a 72-in. David Brown-Muir machine, capable of producing gears to Grade A accuracy. Most of the hardened components made, are shaved before nitriding, with no subsequent process to the profiles of the teeth, but in some cases, components which have been carburized and hardened are subsequently ground on Maag machines.

The two Sykes 3C shaping machines installed, were specially built to W. H. Allen Sons & Company's own specifications, in order to obtain the necessary extreme accuracy required. These machines are used for producing epicyclic gear sun and planet wheels, in which both helices may be cut simultaneously, and also for the production of internal gear rings.

All gear-tooth components are thoroughly inspected in a part of the gear shop which is well equipped with special measuring machines, including two Maag PH.60 machines, and a No. 2 and No. 4 Goulder gear checker. An important feature of the organization is the complete inspection record which is kept of all the gear tooth components manufactured. The record gives the composition and hardness of the material used, and includes the details of all checks of tooth profile, helix angle,

pitch to pitch accuracy and final hardness after hardening.

The northern arm of the cruciform is laid out as the fitting, assembly and testing shop, which is completely equipped for the assembly and testing of all sizes of gear units made. In the testing area, a Ward-Leonard control-system is used in conjunction with d.c. motors to provide variable-speed running conditions, and also there is a small high-speed water brake for light-load tests.

Throughout the premises, materials, components and finished gears are transported and stored on pallets. Adjustable pallet racks are installed to make the best use of the available space and to accommodate the wide variety of component sizes and shapes.

As already mentioned, hardened components used in the epicyclic gears are usually nitrided. The nitriding plant installed at Atlas Works, is capable of nitriding wheels up to 20-in. pitch circle diameter, which surprisingly enough, will meet the requirements for many gears capable of transmitting powers up to 20,000 hp.

Also in the nitriding shop are facilities for the white-metal-lining and facing of all bearings and planet-wheel spindles. Although it is unusual for white metal to be applied to the outside of a spindle, special techniques have been developed for this treatment, which offers technical advantages and is considered essential for the bearings of planet wheels to be formed in this way. Honing, which is applied to the bores of the wheels which run on the spindles, is the only post-nitriding operation carried out.

Optical Aid to Smoke Assessment

Designed on the style of binoculars, but with only one viewing aperture, the Smokescope contains a standard film disc of smoke density which is viewed against the background adjacent to the chimney. This method ensures that the film receives light from the same source as does the smoke, any background differences affect both the smoke and the disc and ambient light plays no part in the observation. Accuracy of the estimations is further enhanced by the use of a lens which projects a virtual image of the disc to a focal distance equivalent to that of the smoke. The observer can, therefore, make a comparison without changing

The Smokescope with the eye piece in position. The strap (top left) can be attached to the instrument by means of the "buttons" which can be seen. The instrument is carried in the strong leather case

the focus of his eyes. The density disc which is contained in the barrel of the Smokescope is based on the Ringleman Chart Nos. 2 and 3. A mirror projects the image of the disc through the lens on to an image mirror. The smoke is seen through an aperture in this mirror where it can be compared with the image of the density disc. A shield cup on the eye piece helps to keep out any extraneous light.

The M.S.A. Smokescope is produced by Mine Safety Appliances Company Limited, Queenslie Industrial Estate, Glasgow, E3.

Cutting Short Threads with a Coventry Diehead

A new type Coventry diehead equipped with external tripping mechanism and designed for use on single-spindle automatics is ideally suitable for cutting short threads. The diehead can be set to trip almost immediately the dies commence cutting and the possibility of the diehead opening due to centrifugal force produced by the very rapid indexing of the turret on these high speed machines is eliminated. The diehead is fitted with a spring-cushioned shank which provides bilateral movement to compensate for the slight difference which may exist between the pitch of the thread and the forward motion provided by the feed cam. This cushion-action ensures a good start to the threads and also, with the substantial sliding dogs, provides an easy sliding movement ensuring long die life.

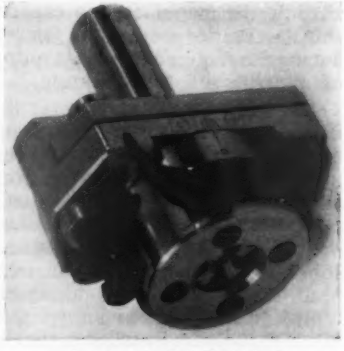
The Coventry $\frac{1}{4}$ in. Style XT diehead made by Alfred Herbert Limited, Coventry will cut threads from 12 B.A. to $\frac{1}{4}$ in. Whit with appropriate dies, and as the shank is hollow, screws of any length can be cut.

Underwater Limit Switch

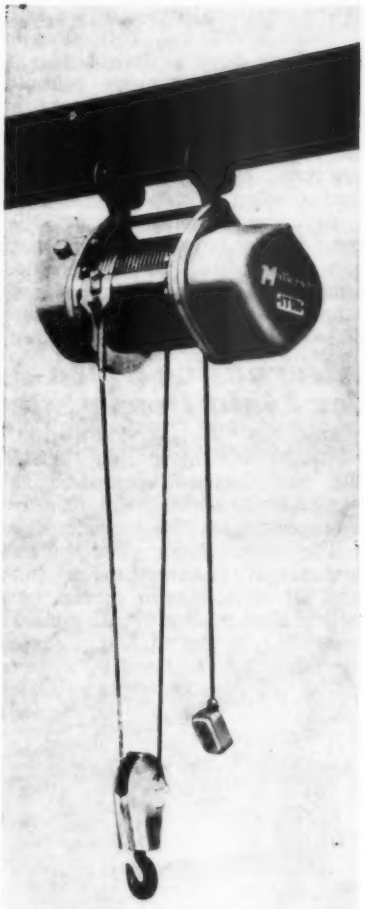
A watertight limit switch, for a.c. or d.c. applications where complete submersion is involved, has been developed by Brookhirst Switchgear Limited, Chester. It is single pole, self resetting, quick make and break, and may be arranged either for

Watertight limit switch for roller lever operation

direct operation or by means of a roller lever. The switch with a plain push requires 6 lb pressure to give an operating movement of $\frac{1}{8}$ in. and an overtravel of up to $\frac{7}{32}$ in. is permissible. The roller lever operated switch is actuated by $3\frac{3}{4}$ lb pressure with $\frac{3}{16}$ in. movement and $\frac{5}{16}$ in. overtravel. Rated for up to 550V and a maximum current of 10 amp, it can be connected to operate as a normally closed or normally open switch for single circuits or both sets of contacts can be used, one to break and the other to make circuit when the plunger is depressed.



Coventry $\frac{1}{4}$ in. Style XT diehead



Matterson 101 electric hoist block, 1 ton capacity

All-enclosed Geared Hoist

One of the main features of the Matterson 101 electric hoist block is that the gears are all mounted on ball or roller bearings, running in a totally-enclosed oil-bath gearcase. The barrel is supported on the full diameter in grease lubricated roller tracks in all steel frames. The hoist, which is arranged to lift up to 1 ton, through 23 ft at 20 fpm, is equipped with positive rope guide operated shunt and series over-winding and over-lowering limit switches. Control is by "hold-on" type pendant push button, and mechanically interlocked air break reversing contactors are mounted under a fibreglass end cover.

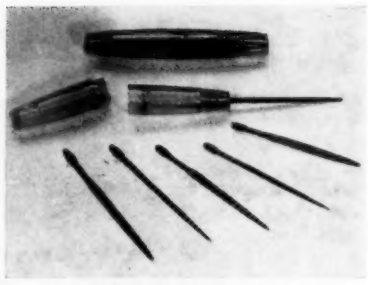
The makers, Matterson Limited, Healey Works, P.O. Box No. 31, Rochdale, Lancs, supply the hoist in the usual fixed suspension and pedestal mounting forms—push, hand chain, and power travelling suspension trolleys. In patent low headroom construction the hoist occupies only 13 in. of headroom. All trollies are adjustable for varying beam widths up to 6 in. wide. Prices range from £168 for the push travel model to £225 with power traverse.

Sintered Metal Clutch Facing for Marine Drives

A sintered bronze-based friction material, Ferodo SM7, designed for dry applications only where smooth take-up characteristics are required, notably in marine reversing gear boxes is announced by Ferodo Limited, Chapel-en-le-Frith, Stockport.

The material which is supplied sintered either to metal core or backing plates has the following characteristics:

Static friction value (dry)	0.32 to 0.34
Dynamic „ „ „	0.29 to 0.31
Density	4.9 g/c.c.
Ultimate tensile strength	4700 psi
Cross breaking strength	9100 psi
Shear strength	5100 psi
Friction value for design purposes (dry)	0.25



The 6-in-One pocket file

Handy Combination File Set

Any one of six assorted files which are contained in a translucent amber case may be inserted in the brass socket at the end, the case forming the handle. The files are round; half-round; crossing; flat; square and three-cornered. The 6-in-One combination file is manufactured by J. Stead & Company Limited, Manor Works, Sheffield 2, and retailed at 10/9d.

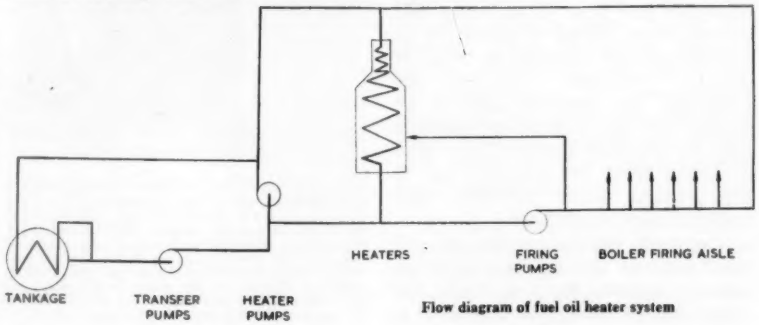
Fuel Oil Heating Without Steam or Electricity

A scheme for heating fuel oil up to firing conditions without the use of steam or electrical heating has been developed by Foster Wheeler Limited, 3 Ixworth Place, London SW3. Direct fired heaters are employed and provision is made for heating tankage and offsetting heat losses from piping without using other heating media.

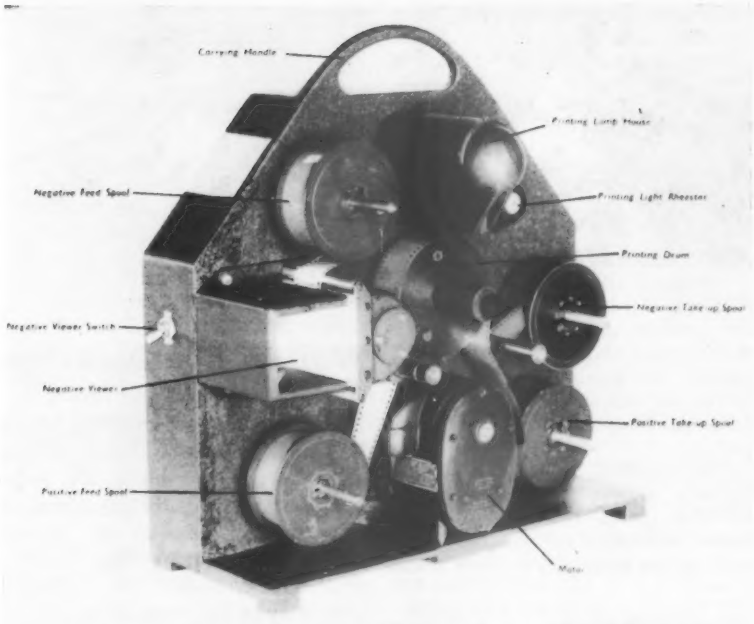
The scheme which dispenses with the need for auxiliary boilers, steam tracing, steam trapping, condensate handling and feed water treatment is claimed to considerably reduce maintenance costs and increase overall thermal efficiency. Efficiencies up to approximately 80% are possible based on a heating load consisting of heating fuel oil to the firing temperature and offsetting thermal losses from oil piping and tankage.

The basic scheme is depicted in the flow diagram and is applicable to reasonably compact installations, such as power stations, having a total heating load of 10,000,000 B.t.u. per hour minimum and fuel oil with viscosities up to 6000 sec Redwood No. 1 at 100°F and possibly higher. The only utilities required during normal running are fuel oil for the heaters, electrical power for the pumps and air or electricity for instrumentation.

Capital costs would appear to be similar to those for a steam heated scheme inclusive of steam generation but operating and maintenance costs are claimed to be considerably reduced.



Flow diagram of fuel oil heater system



The portable Fairey contiuuous printer prints length nf up to 100 ft of 35/70 mm film at 9 fpm

Continuous Printer for 35/70 mm Films

An inexpensive continuous printer for 35 mm or 70 mm negative film, designed by Fairey Air Surveys Limited 24, Bruton Street, London, W1, is being marketed for printing record traces and aerial films and for producing duplicate negatives by using positive stock.

To adapt the machine for either size of film takes only a few moments while the appropriate printing drum is fitted to the centre shaft and the guide plates on the feed side are adjusted to the required width. The machine prints lengths of up to 100 ft maximum of film at a constant speed of 9 fpm and the exposure is adjusted by varying the intensity of the printing lamp. A viewer is provided between the negative feed spool and the printing drum so that the negative may be viewed continuously just prior to printing and the exposure varied if necessary to compensate for changes in negative density, without stopping the machine. The viewing light is an orange safelight so that the machine may be operated in a darkroom and a tunnel from the lamp house to the printing drum prevents light spill outside the machine.

The feed spools are on the left hand side of the machine and the take-up spools on the right, the upper spools being the negative to be printed and the lower spools the positive material. From the feed spool the negative passes through the viewer and then meets the positive material, after which both are threaded round a polished roller and fed on to the printing drum. On passing round the drum good contact is ensured and at the top of the drum the printing exposure takes place. After exposure the negative and positive are separated once again and rewound on separate spools.

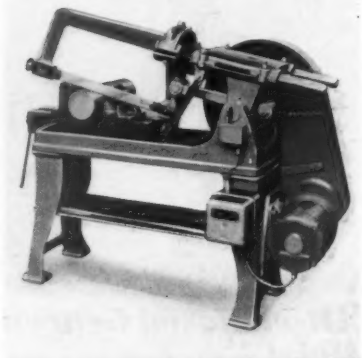
The printing drum is driven at a constant speed and both take-up spools are power driven but at a faster rate with slipping belts to ensure a continuous steady take-up from the printing drum. Over feeding from the feed spools is prevented by friction discs on the feed spindles.

Exposure is made by a 30-W pearl tubular lamp which is fitted in a well ventilated but light baffled lamphouse. A tunnel from the lamp-house has a $\frac{3}{8}$ in. exposing aperture close to the top of the printing drum.

Alternative Drive for Light Power Saw

Whilst the "Rapidor-Manchester" light-duty sawing machine retains the main features of the original design, a new alternative motor drive arrangement has been provided.

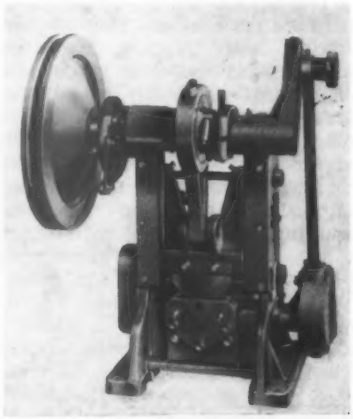
The geared-motor drive unit is mounted at the rear of the machine and drives it through a single vee pulley. This is an alternative to the older arrangement whereby the machine is mounted on a baseplate which holds the motor mounted on slide rails, the drive being through double reduction vee pulleys using an intermediate counter-shaft.



Rapidor-Manchester 6 × 6 in. sawing machine with modified motor mounting and drive

Adjustable automatic electrical stop and push-button starter with no-volt and three over-load releases is supplied as standard equipment, and so eliminates the mechanically operated starting handle, clutch and knock-off lever in the older design.

Owing to the characteristics of the drive, the machine is only available to operate at a single speed of 100 strokes/min. using 380/440 V, 3-phase, and single-phase 220/240 or 230/250 V. The machine has a capacity of 6 × 6 in. and is made by Edward G. Herbert Limited, Atlas Works, Levenshulme, Manchester 19.



GUILLOTINE TUBE CUTTING ATTACHMENT
A simple device which forms an attachment to be fitted to the standard 5 in. Model "Autogil" guillotine made by Wallis Engineering Company, 399 Warwick Road, Birmingham, facilitates the cutting of tubes or rods of polythene and similar materials. Pieces of up to $\frac{1}{2}$ in. OD produced by this attachment are square cut to within ± ·010 in. and the output is 240 pieces per min based on 8 in. long pieces. The machine can be hand-operated or motor driven by V-belt

Hinkley Point Cooling Water System

The Hinkley Point power station, with its electrical output of 500 MW, demands a cooling water circulation of 35M gallons of water an hour. This volume of water will flow to the site through two 11-ft dia tunnels about 2,000 ft long, driven under the Bristol Channel for most of their length, to the intake structure, a concrete island to be constructed about a third of a mile off-shore.

In addition to the progress on the reactors and associated works, considerable progress has now been made on the cooling water system which is the largest of its kind to be required for a nuclear power station.

The concrete structure of the "island" will be floated, Mulberry Harbour fashion (Taylor Woodrow were one of the firms engaged on this war-time project) from a dry dock on the west side of the site. This dry dock has been finished and its semi-circular ring of steel sheet piling will be removed, at the appropriate time and tide, for the intake structure to be towed into its permanent position in about seven months' time (spring 1959).

The structure itself will be a reinforced concrete caisson, 60 ft high and 96 ft dia, in the shape of an upright cylinder and, with its false bottom, will have a dead weight of 3,000 tons approximately when towed to position.

When placed, it will rest on the sea bed on eight "spud leg" supports, hollow steel columns, 60 ft long and 4 ft dia.

A ring of steel piling previously suspended around the floating structure will then be driven into the sea bed to provide a cofferdam, within which the intake and tunnel connexions will be completed.

The intake system has been designed to supply a second Hinkley Point station, the probable cooling water requirements of which would be 50 M gallons of water an hour (totalling 85 M gallons for the two), but only the off-shore ends of the two larger 13-ft dia tunnels will be constructed at this stage.

On the shore-side, an 18-ft dia approximately 100-ft deep access shaft has already been sunk behind the completed sea wall (which thus acted as a cofferdam for these works as well as a general site protection) and a 7-ft dia pilot access tunnel is being driven seawards. This will be lined with cast iron segments. Where they leave the access shaft, the two main water tunnels, concrete lined, will have an invert level 92 ft below finished ground level.

Driving will begin from a cross-heading itself driven from the access shaft, and proceed to the intake structure in one direction and back to the pumphouse in the other. Seawards it will stop short of the intake structure until the main portion of the work is completed there. Then tunnels from the intake structure will link up with them.

Each of the inlet tunnels will supply one half of the Pumphouse Forebay, and from the pump chamber, water will flow to the condensers in the turbine hall through twin delivery culverts, 8 ft 6 in. square, constructed in open cut and approximately 35 ft below finished station level.

The inlet culverts have been designed to carry the outlet culverts directly on top of them for a distance of 700 ft from the turbine hall. The outlet water will be led 1,100 ft in all to a reinforced concrete seal pit behind the sea wall at the eastern edge of the site. From there it will be discharged through a further 800 ft of concrete culverts to a head wall off-shore, beyond which a channel will be excavated in the open water. Final discharge will be some 2,300 ft. east of the intake point.

The off-shore outlet culverts and the head will be constructed in one large steel sheet-piled cofferdam over 800 ft long in which excavation for the culverts is now proceeding.

The cooling water pumphouse with its adjoining screening bays, suction dock and pressure chambers will all be below ground level with an adjoining chlorination house above ground level.

T.V. Inspection of Pluto

Remote inspection of reactor components without removal from the reactor will greatly reduce radiation hazards to personnel and the time required for preventive maintenance. This has now been achieved by E.M.I. Electronics Limited, Hayes, Middlesex who have developed a high-definition closed circuit television system for use in nuclear reactors, and which is now operating at the Atomic Energy Authority's establishment at Harwell.

The cylindrical camera unit, which measures only three inches in diameter and is approximately 48 in. long, is constructed so that it can be lowered through an inspection cover directly into the reactor Pluto's heavy water. A transparent tube encases it to afford protection. A remotely controlled mirror mounted in front of the lens enables the operator to view all parts of the interior of the reactor, which has been specially illuminated. Switched scan reversal circuits have been incorporated in the camera control unit to compensate for reversal of the mirror's reflection. The E.M.I. camera channel works on the 625 line system.

Reactor Charging Machines

The charge machine at Bradwell Nuclear Power Station is carried by a pair of large girders, each 102 ft long, 12 ft deep, 2 ft 6 in. wide and weighing 106 tons. The girders have been made by J. S. Forster Limited, Tipton, on sub-contract from Strachan and Henshaw Limited the designers and manufacturers of the charge machine which refuels the reactor while it is on load and also carries out servicing operations involving various active components used in the reactor. To protect personnel from radiation given out by the fuel and components, the machine is heavily shielded and its operations over the reactor are controlled remotely from a control room overlooking the pile cap. Each charge machine is carried on a structural steel travelling gantry spanning the reactor pile cap, and the combination of gantry travel and machine traverse enables the machine to be positioned over any of the standpipes giving access to the reactor, and also over any of the various storage holes around the reactor. Each complete machine weighs 400 tons and traverses on four two-wheel bogies; the gantry has a weight of 350 tons and travels on eight two-wheel bogies. The traverse and travel motions are controlled locally on the pile cap.

Strachan and Henshaw Limited supplied the whole of the fuel handling equipment for the four reactors at Calder Hall nuclear stations and again for Chapelcross.

* this makes sense
— Please check

Who buys tool bits for your shop?

MP

Here are some things he should know . . . .

No tool bits can be better than the steel they're made from

'Eclipse' tool bits are made from H3 cobalt high speed steel, melted, heat treated and finished under one control to strict and rigid standards of quality. That's why the consistent performance of 'Eclipse' tool bits can be guaranteed.

Cheap tool bits can mean dearer production costs

When you buy tool bits you buy cutting capacity and it pays to buy the best. 'Eclipse' tool bits keep keen cutting longer than inferior tools — reducing time out for regrinds and increasing production.

Tool bit holders can help with production too

'Eclipse' tool bit holders have been specially developed to get the very best from 'Eclipse' tool bits. They have a patent clamp, adjustable to variation of tool bit size which holds the tool absolutely rigid eliminating any tendency to "chatter."

This is just what we need

'Eclipse' tool bits and tool bit holders are the ideal cutting combination

specify Eclipse TOOL BITS

Made by James Neill & Co. (Sheffield) Ltd., and obtainable from all tool distributors.

UT 13

Ask the machine shop to check this

Hydraulic Turbines; Their Design and Equipment. By M. Nechleba. Prague, 1957; Artia. London, 1958; Constable & Co. Limited. 45/- net (by post 46/9). 636 pp. 5¾ × 8 in.

The actual work of designing hydraulic turbines requires much more than is usually found in books on hydraulics. When it all comes to be written down we get a substantial volume such as this one by Professor Nechleba, who deals ably with the theory, the design of the machines, their equipment and starting-up procedure and the taking of guarantee measurements. Francis, propeller and Kaplan turbines and Pelton wheels are all dealt with thoroughly both as regards the designs of the runners, passages and nozzles, and the design of the machine and constructional units. Equally detailed treatment is accorded the design of controllers, thrust bearings and conduits. The book is profusely illustrated and a pocket in the back cover contains a number of folding plates presenting the larger diagrams and sectional drawings.

Technical Drawing. By Frederick E. Giesecke, Alva Mitchell and Henry Cecil Spencer. New York & London, 1958; The Macmillan Company. 52/6 net (by post 54/9). 844 pp. 7 × 10 in.

There are more kinds of drawing than mechanical, structural or architectural. There is also, for instance, technical illustration, and an important branch of the subject has to do with the practical uses of mathematics. The all-embracing description used by the authors of this book is the title they have chosen—technical drawing—and their covering so many kinds of drawing has resulted in quite a large book.

They regard technical drawing as a graphic language of great antiquity. Its widespread use, with which they are mostly concerned, is, however, of the present industrial age. They deal very thoroughly and in complete, painstaking detail, with equipment and methods for mechanical drawing, lettering, geometrical construction, technical sketching and shape description, multi-view projection and sectional and auxiliary views, views obtained by revolution, dimensioning, tolerancing, axonometric and oblique projection and perspective, intersections and developments, graphs, line charts, and the graphical solution of mathematical problems, structural drawing, topographical drawing and mapping, piping draughting, welding representation, aeronautical draughting, shading and patent draughting.

The various drawing techniques are not, of course, all that is required in order to make a drawing. The working drawing itself presents a subject for study, and apart from the specialist knowledge of what is actually drawn there are the shop processes to be taken into account, the various methods of fastening to be applied, and such widely used items as gearing and cams to be understood. Then again, before a drawing becomes of practical use it has to be reproduced. All these aspects are treated in this book, which, though of American origin and therefore in terms of American standards where such and their like are mentioned, is nevertheless a notable treatise which will interest the experienced draughtsman as well as being of particular use for teaching, for which purpose it is very well supplied with examples.

books

Cast Tools. By Z. Eminger and V. Koselev. Translated from the Czech by CH. Caslavsky and G. A. Evans. Prague, 1957; Artia. London, 1958; Constable & Co. Limited. 20/- net (by post 20/9). 230 pp. 5¾ × 8 in.

This book contains the results of two years of investigation and experiment directed at finding a reliable and satisfactory method of producing cast tools. In the course of their work the authors surveyed the properties of steel, compared cast and forged tools, examined the various tool casting and production methods, and studied the particular problems arising out of the casting of tools in high speed steel and the practical and theoretical aspects of heat treatment. They appear to have set down all that they found out and the result is a complete treatise on this specialized subject. For final use they select the inverted furnace with controlled atmosphere.

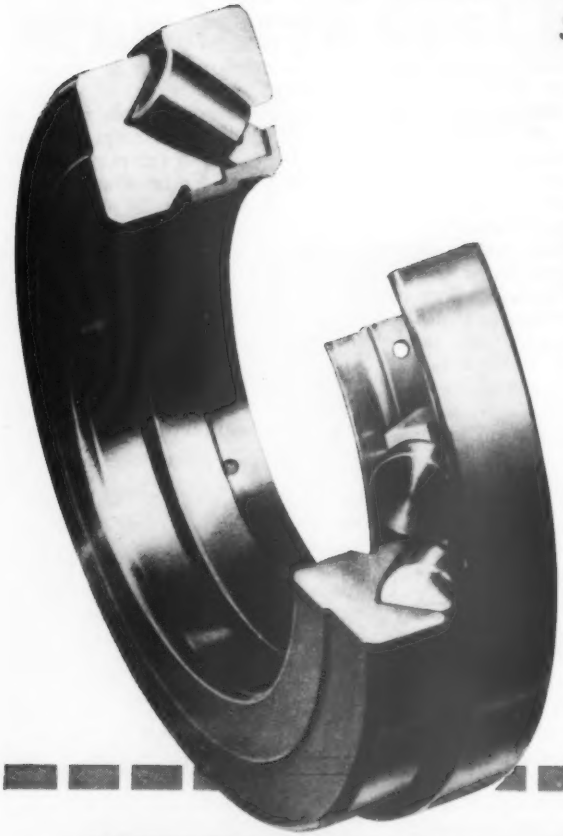
Radiographs of Aluminium Welds.—A new booklet published by the British Welding Research Association, which shows how to identify those defects in aluminium fusion welds which can be seen in radiographs. The defects are classified, their origin explained and suggestions for their prevention are made. General indications are given of the ways in which the defects influence joint properties, but except for uniform porosity this is only qualitative. A simple system is given for recording the severity of uniform porosity and its probable effect on joint efficiency. No attempt has been made to indicate acceptance standards although the booklet may well form a useful basis for discussions on such standards. The book, H3/58, entitled "Classified radiographs for defects in aluminium fusion welds", is available, price 10/-, from the British Welding Research Association, 29 Park Crescent, London W1.

Factories Acts.—If any piece of legislation requires accurate interpretation in straightforward, readily understandable language it is the Factories Acts, for they are at once the guide to and the law on safe working practice as well as defining liability. The United Steel Companies did a public service in 1945 in making generally available their own expert's summary of the Acts, written in the language of the layman and bringing together in a handy reference booklet the main provisions of the Acts as applying to the iron and steel industry. This summary has now been revised and brought up to date by the company's safety consultant, Mr. N. H. Jones. The booklet may be regarded as authoritative as Mr. Jones, an ex-Deputy Chief Inspector, served with H.M. Factories Inspectorate for 42 years. Copies may be obtained, free of charge, by interested persons on application to the Welfare Office, The United Steel Companies Limited, 17 Westbourne Road, Sheffield 10.

The New Materials.—A popular exposition of the composition and use of the newer engineering metals and plastics is given in a new book, "The New Materials", by Gerald Leach, published by Phoenix House, price 9/6 net (by post 10/1). The fundamentals (particularly the chemistry) of the subject is treated in a way likely to be acceptable to those without any familiarity with scientific terminology, and the book is well illustrated with photographs and line drawings. It will make a good present for the scientifically inclined youngster besides being of use to anyone who wants a simply written introduction to the subject.

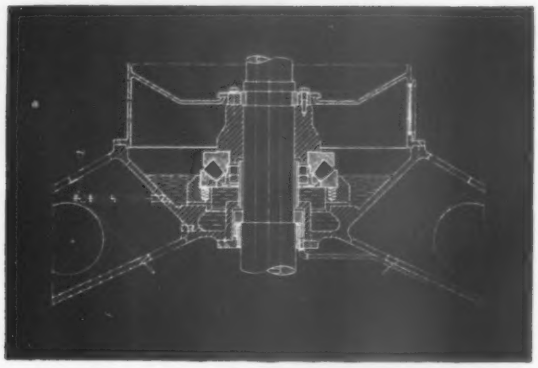
Textile Machinery Index.—The newly issued second edition of

Only SKF can offer such a wide selection of British made bearings

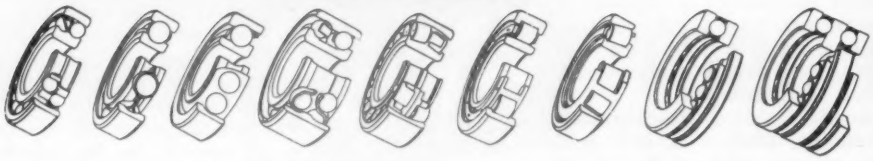


The spherical roller thrust bearing has one row of obliquely disposed rollers guided by a high flange on the shaft washer and running on a sphered track on the housing washer. It combines very high carrying capacity with complete self-alignment. The surface of the roller end next to the guiding flange is so formed that the rollers are always separated from the flange by an oil film when under load. The bearing can therefore be used at relatively high speeds, even if the load is very heavy. Unlike other thrust bearings, it can also carry radial loads.

Technical advice on the application of spherical roller thrust bearings, as well as other types of rolling bearings is always readily available from Luton or from any one of the twenty Skefko Branch Offices in the British Isles.



Support bearing for vertical electric generator



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THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G181A

"Textile Machinery Index" has a large directory section cataloguing the activities of the textile engineering and accessories industries, and a separate section dealing with textile chemicals and having its own buyer's guide. A further feature is a multilingual buyer's guide, printed on distinctively coloured paper, for machinery, accessories and mill supplies. The Index is published by John Worrall Limited, Central Works, Oldham, Lancashire, from whom it is available price two guineas post free. It is published at three-yearly intervals.

The Effect of Technological Progress on Education.—A bibliography of this title has been prepared by the Hazleton Memorial Library and is available from the Institution of Production Engineers, 10 Chesterfield Street, London W1, price 14/6 (by post 15/6). The bibliography is not comprehensive, but is intended to be a guide to the development of technical education during the period covered. Independently of its use as a bibliography, it should serve as a summary of opinion on the subject. It is very likely the only bibliography on the subject.

FEDC Year Book.—The 1958–9 edition of the year book of the Federation of Engineering Design Consultants (St. Stephen's House, London SW1, price 5/-) sets out the aims, objects and history of the federation, its bye-laws and regulations, the standard terms of business and code of professional conduct, and lists its members alphabetically and under classified engineering divisions. There is also a geographical classification. The "Terms of Business and Code of Professional Conduct" is available separately, price 1/-.

Cold Galvanizing.—A booklet entitled "Zinc Dust in Paints" issued by the Zinc Pigment Development Association, 34 Berkeley Square, London W1, is a completely new version of an earlier publication and includes comprehensive information about the uses of zinc dust paints and many photographs of their varied applications. A list of contents and bold section headings make for easy reference. The booklet provides a general guide to the composition, properties and uses of the various types of zinc dust paints, both those which are in commercial production and those which are still experimental. Much of the text deals with "zinc-rich" paints which have been developed during the last 20 years, mainly in Great Britain, and which are perhaps the most valuable of all paints containing zinc dust. When dry the zinc-rich paint film contains 92% or more of metallic zinc in a special organic binder, and so it protects steel sacrificially in the same way as other metallic zinc coatings. Zinc-rich paints are thus particularly suitable for new steelwork and for the repair of damaged zinc coatings on older structures. The booklet also discusses other zinc dust paints, such as inorganic silicate paints and zinc dust/zinc oxide paints. Copies are available from the association free of charge.

Electrical Industrial Data Sheets.—Readers will have noticed the new advertisements of the Electrical Development Association, headed "Electrical Aids in Industry" and taking the form of illustrated data sheets, each outlining a particular application of electricity and stressing the advantages resulting from its use. The sheets are marked for perforation so that they can be removed and kept together in a folder for future action by industrialists, works managers, and production engineers generally. Those issued or in course of preparation up to the present are entitled: Electro-Heat, Induction Heating 1, Induction Heating 2, Resistance Heating 1, Resistance Heating 2, Light-Sensitive Cells, and Industrial Lighting. Others will follow from time to time covering such subjects as electronics and automation. Copies of the data sheets can be obtained after publication as advertisements on application to the Electrical Development Association at 2, Savoy Hill, London, WC2.

Business and Specialized Publications of Great Britain.—The Council of the Trade and Technical Press, Imperial House, Kingsway, London WC2, have issued a new illustrated booklet listing the trade and technical journals of Great Britain. Each journal is briefly described, and in each case the description is accompanied by an illustration showing the cover of the journal. In an introduction, Sir David Eccles, President of the Board of Trade, remarks how British technical and trade journals have played a notable part in helping British industry to reach its present high level of efficiency and in making British products and achievements known throughout the world: he commends the booklet to all interested in new techniques, the purchase of equipment or in choosing consumer goods.

New Standards

Flexible steel tubing to enclose flexible drives for power-driven tools for general purposes (B.S. 731:Part 2:1958) Price 3/-.

This revised eight page illustrated publication deals with flexible steel tubing of two types, interlocking and locking. It specifies dimensions mechanical requirements and suitable qualities of steel strip and asbestos packing for its manufacture. The first part of the revised version of B.S. 731 was published in 1952 under the title 'Flexible steel conduit and adaptors for the protection of electric cable'.

Steels for use in the chemical, petroleum and allied industries (low temperature supplementary requirements to B.S. 1501-1506) (B.S. 1510:1958) Price 4/6.

This new publication is a companion to the revised edition of B.S. 1501-1506 'Steels for use in the chemical, petroleum and allied industries'. It relates to 18 steels for operation at low temperatures and to applications where a high degree of notch ductility is required.

Special limits (other than those laid down in B.S. 1501-6) are specified for the chemical composition of three of the steels; and there are details regarding the selection and number of impact test pieces and the method of performing the impact tests—together with a list of the mechanical properties to be obtained.

Sulphuric acid for lead-acid batteries (B.S. 3031:1958) Price 4/6.

This 16 page publication specifies limits for the presence of: residue on ignition, chloride, sulphur dioxide, combined ammonia, nitrogen (other than combined ammonia), iron, copper, magnanese and arsenic. They are followed by nine appendices, each containing a detailed method for determination of these constituents. A final appendix provides a formula for calculating the volume of sulphuric acid to be taken for test.

British Standards Institution, 2 Park Street London, W1.

"DIXOL"

SOLUBLE CUTTING OILS

chosen by CROSSLEY BROTHERS LTD

Dixol is used on this intermediate machining operation on a cylinder liner for a Crossley diesel.

Crossley Brothers have been engineering specialists for as long as 91 years, and the soluble cutting oils they use to aid them manufacture their diesel engines are "Dixol" grades, production oils of proven quality and performance—backed by 104 years of specialised experience in lubrication!

The Guiding Light in Lubrication

INDUSTRIAL WAKEFIELD-DICK LUBRICANTS

WAKEFIELD-DICK INDUSTRIAL OILS LTD.
67 Grosvenor Street, London, W.1
A MEMBER OF THE WORLD-WIDE WAKEFIELD CASTROL ORGANISATION

BUSINESS & PROFESSIONAL

Personal

Mr. H. E. Cooper has been appointed managing director of G. A. Harvey & Co. (London) Limited. Mr. Cooper, first appointed to the board in 1946, has been acting as deputy managing director since May of this year. **Mr. I. A. Marriott** succeeds **Mr. P. T. Bliss** as sales director. Mr. Bliss, who has been with the company for 50 years, retires on December 31.

Mr. R. F. Hatto, sales director of Wolf Electric Tools Limited, has retired after 45 years' service with the company.

Mr. Richard Turner has been appointed a managing director of Johnson, Matthey & Co. Limited as from October, 1958. He has relinquished his position of managing director of Mallory Metallurgical Products Limited, a subsidiary company, but remains a director.

Mr. Leonard Baker, M.I.M.E., A.M.I.Prod.E., M.A.S.M.E., has been appointed deputy managing director of Coventry Gauge & Tool Co. Ltd. After distinguished service with the Royal Navy, Mr. Baker retired with the rank of Commander (E) in 1948 and has spent the subsequent 10 years in industry, relinquishing his position with Hamworthy Engineering Company to take up this appointment.

Mr. Geoffrey N. Iley, B.Sc.(Eng.), formerly assistant general manager of the M.G. Car Co. Limited, has been appointed production manager of Morris Motors Limited, Cars Branch, Cowley, Oxford.

THE GRESHAM TRANSFORMER GROUP, Twickenham Road, Hanworth, Middlesex, announce that the technical side of the Power and Distribution Transformer Division is now under the charge of the recently appointed chief engineer, **Mr. Robert James Gresley, A.M.I.E.E.**

Two additional technical representatives have been appointed to the outside sales staff of the rapidly expanding retaining ring division of Geo. Salter & Co. Limited, West Bromwich. They are **Mr. Geo. Taylor** and **Mr. C. D. McWhinnie.** Mr. Taylor has been with Salters all his working life, starting in the tool room twenty-six years ago. Since 1951 he has been methods engineer for the firm's retaining ring and fastener products. He will cover the Midland region. Mr. McWhinnie, who will be based on the company's Manchester office, has had considerable engineering experience in the fields of jig and tool design, light mechanical handling and contractors' plant, and textile machinery.

ENGLISH STEEL CORPORATION LIMITED announce the following appointments to the boards of their operating companies. English Steel Forge & Engineering Corporation Limited, **Mr. W. H. Stratford, Assoc.Met.F.I.M.,** superintendent, steel melting; **Mr. R. W. Brocklehurst, M.I.Prod.E.,** superintendent, heavy forge production. English Steel Rolling Mills Corporation Limited, **Mr. P. Turrell,** who will also hold the office of assistant managing director. English Steel Castings Corporation Limited, **Mr. L. R. Evans, M.I.Mech.E., M.I.Prod.E.,** superintendent, foundries. English Steel Spring Corporation Limited, **Mr. R. Fielding, M.I.Prod.E.,** superintendent, spring production.

GEORGE KENT LIMITED announce the recent appointment to the board of their Belgian Subsidiary Company, Kent-Continental S.A., of **Mr. F. J. Havenith** as local resident director. Mr. Havenith has been the manager, first of Kent's Brussels Office and subsequently of the Belgian Company, since its formation.

Mr. R. E. Kaan (Dipl. Ing.) has been appointed export sales manager of S. N. Bridges & Co. Limited, London, portable electric tool manufacturers. He was formerly with B.E.A.M.A. **Mr. Tom Blyth** has been promoted to the position of home sales manager.

BRITISH INSULATED CALLENDER'S CABLES Limited announce the retirement of **Mr. John Taylor,** deputy works manager at their Leigh Works, after almost fifty-one years' service with the company. In 1907 Mr. Taylor joined the rank and file of the Callender Company and since then had worked his way progressively to the position he held at retirement. At a farewell gathering Mr. Taylor was presented with a gold wrist band on behalf of the employees and his management colleagues made a further gift of a silver salver. Yet another presentation of a record player by the Foremen's and Supervisors' Guild marked the overall respect and esteem in which Mr. Taylor was held.

Mr. A. C. Burn of Sales Audits Limited has been elected to the board of North West Machine Design Company Limited.

Mr. J. S. Lees, A.M.I.Mech.E., formerly sales manager (passenger vehicles) of Leyland Motors Limited, has been appointed home sales manager for Leyland and Albion goods and passenger vehicles. Mr. Lees has transferred his office to Hanover House, Hanover Square, London W.1.

Mr. B. Homfray-Davies, who for 25 years was managing director of Metropolitan Cammell Weymann Limited, has been appointed managing director of Arusha Industries Limited.

THE UNITED STEEL COMPANIES LIMITED announce that **Mr. T. W. Hall,** who until recently was under-manager of the company's Santon mine at Scunthorpe, has been appointed manager of the new Easton mine, and **Mr. J. Darragh** has been appointed under-manager at Santon. The Easton ironstone will be the first to be developed on the Northamptonshire sands ironstone bed.

METROPOLITAN-VICKERS ELECTRICAL COMPANY Limited announce that recent appointments in the company's manufacturing departments include those of **Mr. D. Hutton, A.M.I.Mech.E.,** assistant superintendent, switchgear department; **Mr. V. D. Swain, B.Sc.(Eng.),** superintendent, control department; **Mr. F. G. Rose,** assistant superintendent, main production; and **Mr. K. R. Johnston, B.Sc.(Eng.),** assistant superintendent, plant department.

Mr. H. P. Lord, A.F.C., B.Sc., general sales manager of Sigmund Pumps Limited, has been appointed to the board.

Mr. Graham Almrott has been appointed to the board of directors of the Caterpillar Tractor Company Limited.

Obituary

WE regret to record the death at the age of 53, of **Mr. Edward Francis Hunt, J.P., A.M.I.Mech.E.,** chairman and managing director of Hunt and Moscrop (Middleton) Limited. Mr. Hunt was awarded the associateship of the Manchester College of Technology in Mechanical Engineering in 1927 and after a period of practical training joined his father at the Bowl Works, Middleton. In 1949 he became chairman and managing director of the holding company.

We regret to record the death of **Mr. F. A. Spence-Brown,** a joint managing director of Johnson, Matthey & Co. Limited.

WE regret to record the sudden death in West Africa of **Mr. G. L. R. Pearce,** senior technical representative for the chemical industry of Enamelled Metal Products Corporation (1933) Limited.

We regret to record the death of **Mr. Howard Clayton-Wright,** chairman of Howard Clayton-Wright Limited, designers and manufacturers of specialized aeronautical and automobile accessories, Wellesbourne, Warwickshire. Mr. Clayton-Wright was a life-member of the F.M.I. and on the Midland Council of the National Union of Manufacturers.

SCREW, BOLT or CAVITY FIXINGS

the Speediest way is best!

MODERN BUILDING MATERIALS can be a veritable nightmare to the man who has to deal with the problem of making SPEEDY, PERMANENTLY SECURE FIXINGS having either LIGHT or HEAVY LOADING CAPACITY at an economic cost.

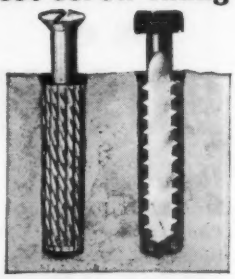
In the RAWLPLUG RANGE there are 21 different types of Fixing Devices, with a tremendous variety of applications. They provide the complete answer to every fixing problem in every kind of material. THE RAWLPLUG RANGE also includes 14 different types of tools for hole boring.

RAWLPLUGS

The World's Largest Manufacturers of Fixing Devices

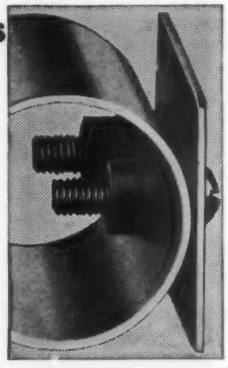
The world's speediest screw fixing

Rawlplugs make firm screw fixings in brick, tiles, cement, stone, etc., in a fraction of the time taken by any other method. Drill the material, insert the Rawlplug, screw up—it's as simple as that! Safe, permanent, and completely reliable in any climate. For all screw sizes up to ¾" coach screws.



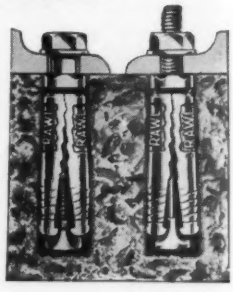
For Cavity fixings

For almost impossible jobs use the Rawlnut. (You can even make a fixing to a pipe). The tapped nut in the end of the rubber bush is drawn up to the reverse face of the material by turning the screw. The result is an airtight, watertight, vibration-proof fixing of enormous strength. For thin plastic, metal, wallboard and hollow pot, etc., it is invaluable.



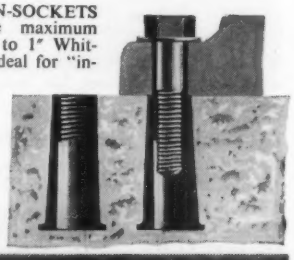
Bolt it down in minutes!

For light or heavy bolting jobs, no other method even *begins* to approach Rawlbolts for strength, ease and speed. Rawlbolts are a *dry* fixing, they grip at once by expansion—no cold chiselling, no grouting in, no waiting for cement to harden. In all bolt diameters up to 1" in either loose bolt or bolt projecting types.



For casting in

Rawlplug CEMENT-IN-SOCKETS are designed to give maximum anchoring value for ¼" to 1" Whitworth bolts. They are ideal for "in-situ" work where the location of Bolt and Socket can be predetermined. Manifold uses for providing anchoring points for all classes of concrete constructional work, including curtain walling, slabs and similar units.



For Speed and Strength!

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HAVE YOU A FIXING PROBLEM? ***For FREE TECHNICAL SERVICE send full details to:—***

THE RAWLPLUG COMPANY LIMITED · CROMWELL ROAD · LONDON · S.W.7

We regret to record the death of **Mr. Cecil Charles Mason, O.B.E.**, a director of Cambridge Instrument Company Limited. Mr. Mason, who was 77, graduated with a First in the Mathematical Tripos at Cambridge, and joined the Cambridge Instrument Company in 1910. He was a joint managing director from that year until his retirement from executive work in 1941, and he remained on the board until his death.

We regret to record the death of **Mr. E. M. Johnson, M.Sc.Tech., M.I.E.E.**, formerly chief engineer of Metropolitan-Vickers Electrical Company's Plant Department (large electrical machines); he relinquished this position in 1955, when he became consultant to the chief electrical engineer until his retirement in February 1956.

We regret to record the death of **Mr. E. W. Steele, M.I.Mech.E., M.I.E.E.**, formerly director and general manager of works, with Metropolitan-Vickers Electrical Company Limited. He retired from executive duties in March 1954. Mr. Steele was also chairman of Metropolitan-Vickers-Beyer, Peacock Limited from its formation in November 1949 to March 1956.

Addresses

Firth Cleveland Finance Limited have opened a branch office at 6 Grey Street, Newcastle-upon-Tyne, 1 (telephone: Newcastle 21511/2), under the managership of Mr. J. C. Ging. This is the third branch office to be opened by Firth Cleveland Finance Limited since the formation of the company in March this year by the Firth Cleveland Group to deal with the hire purchase of industrial plant and for all sections of the motor trade.

Gresham Developments Limited, the specialist company of the Gresham Transformer Group Limited, has now moved to large new premises at Thurlestane House, Uxbridge Road, Hampton Hill, Middlesex. Telephone Nos.: Molesey 4540, 6211, 3059.

The name of The Aerograph Company Limited has now been changed to The Aerograph-DeVilbiss Company Limited in order to tie-up more closely with the symbol Aerograph-DeVilbiss which has long been famous as denoting spray painting equipment.

The office of the German company of the Solartron Electronic Group Limited, Thames Ditton, Surrey — Solartron, G.m.b.H. — is now at Bayerstrasse 13, Munchen, Germany. Telephone No.: Munchen 595109.

The Worcester branch of British Insulated Callender's Cables Limited is now at 4 Charles Street, Worcester. Telephone number as before, Worcester 2070.

Ottermill Switchgear Limited has now moved its London offices to new premises at 82 Victoria Street, London, SW1; telephone Abbey 5095-6.

Charlton, Weddle & Co. Limited, industrial, chemical and marine pipework contractors, of Manors Works, Newcastle-upon-Tyne, have opened a London office at 34 Crutched Friars, E.C.3. The telephone number is Royal 1576. Mr. Gavin Thomson has joined the company to take charge of the new office. Formerly he was with James Mitchell & Co. Limited, of Greenock.

In order to provide additional accommodation for their sales and technical staff, the sales office of Larmuth & Bulmer Limited has now moved to 58 Whitworth Street, Manchester, 1. Telephone numbers Central 6711/2/3.

The telephone number of Wild-Barfield Electric Furnaces Limited of Watford, has been changed to Watford 26091.

Sanders & Forster Limited, one of the Chamberlain Group of Companies, of 3 Buckingham Palace Gardens, London, S.W.1, now has an overseas office in Accra, Ghana, to promote the sales of its well-known range of standard steel-framed buildings covering all industrial applications and also structural steelwork in West Africa. The office will be controlled by Mr. Mark Owusu—a Ghanian—who left the Gold Coast in 1952 to study civil engineering in the United Kingdom. Since obtaining his diploma in Building Engineering with a distinction, he has been trained in the technical estimating and erection departments of Sanders & Forster Limited, and is well qualified to deal with sales and the technical details on the spot.

Philpott & Cowlin Limited and associate company Pee-Cee Engineering Supplies Limited, have removed from Victoria Street, owing to expiration of lease, to new warehouse and offices at 115-119 West Street, Bedminster, Bristol 3. Telephone No. is Bristol 61447/8.

Alexander Kenyon & Co. Limited are now housed in their new headquarters at Akenco House, Elizabeth Street, Manchester 8. This year the company celebrates its centenary.

John Taylor, Dunford & Co. Limited, fire protection engineers and leather, rubber and asbestos manufacturers, of Newcastle-upon-Tyne, have moved into new premises in Sheffield at 173 Attercliffe Road. In charge of the branch is Mr. R. W. Brownill, a local director of the company. Drake & Gorham Limited have acquired new premises for the parent company at 68 St. Ann Street, Salisbury (telephone Salisbury 6544). Correspondence for the parent company, Mr. H. M. Drake, Mr. W. Parker and Mr. W. B. M. Drake should in future be addressed to the Salisbury office. Drake & Gorham (Contractors) Limited of London, Cardiff and Manchester, will now be able to expand into accommodation vacated by the parent company at 36 Grosvenor Gardens, SW1 (telephone Sloane 0121). Drake & Gorham Limited will shortly be celebrating their 75th anniversary.

For the convenience of customers in the Home Counties a flexible warehouse and service depot has been opened by the Compoflex Company Limited, at 109 High Street, Godalming, Surrey. Hose assemblies complete with fittings will continue to be supplied from the company's Oldham factory, through the southern area sales department at Haywards Heath, Sussex. The Godalming telephone number is Godalming 2269. The Haywards Heath number is Haywards Heath 1831.

Welding Technology

The Institute of Welding has recently issued a booklet describing the work of their school of welding technology and detailing the structure of the courses. Full particulars may be obtained from the secretary of the Institute at 54 Princes Gate, Exhibition Road, London SW7.

Film News

Nickel Alloy Permanent Magnets.—This film aims to demonstrate the properties of nickel alloys for permanent magnets, with particular reference to their stability and strength, and surveys some of the latest mechanical and electrical developments which have been facilitated by these materials. Some of the latest uses of nickel alloys in laboratory standards and nuclear resonance magnets are illustrated. Produced in the studios of the Mond Nickel Company Limited, the film is a 750 ft 16 mm sound and colour production and runs for 21 minutes.

Spheroidal Graphite Cast Iron.—The first film on S.G. Iron has been revised and brought up-to-date. It demonstrates how altering the shape of the graphite in cast iron confers upon it unusual properties of strength and ductility. The remarkable ductility of the material in the annealed state is demonstrated and yet S.G. Iron is seen to be stiffer than ordinary cast iron. The film, produced in the studios of the Mond Nickel Company Limited, is a 1000 ft 16 mm sound and colour production and runs for 28 minutes.

The films are available on free loan on application to: The Publicity Department, The Mond Nickel Company Limited, Thames House, Millbank, London, SW1.

3T

CORD Exclusive Goodyear development means stronger, thinner, more flexible transmission belting.

No splice failure
In construction the cord is wound continuously around two pulleys to produce a truly endless belt.

No ply separation
The single layer of load carrying cords round the pulley together, preventing internal stress.

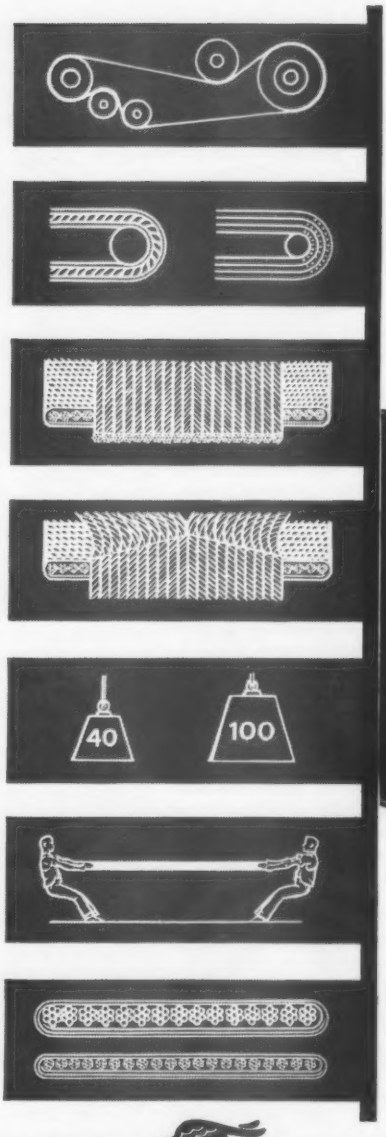
Less lateral movement
To neutralize lateral movement half the cords are twisted to the right and half to the left.

Elastic envelope
Designed to provide high friction surface to grip the pulley and transfer load to the cords.

Stronger 3T Cord
2½ times stronger than cotton and each filament of fibre is continuous, like the cord itself.

Less stretch
Triple Tempering removes surplus stretch but only to a degree where it does not hinder the flexibility of the fibre.

Thinner belt
3-T Cord belt is 25% thinner than belts of equal horse-power rating.



THE amazing new Goodyear 3-T cord process – successfully applied to motor car and commercial vehicle tyres – is also making transmission belts work harder, last longer and cost less for a given horsepower rating.

The synthetic cords are 'triple-tempered' – passed through a process at a controlled Tension and Temperature for a specific Time – to give them maximum strength and flexibility, minimum stretch. The result is that you can use a thinner belt – get improved flex life, longer wear, more efficient transmission and reduced maintenance.

There's a Goodyear 'job-designed' transmission belt for every drive . . . every duty.

NEW HD ENDLESS CORD BELT

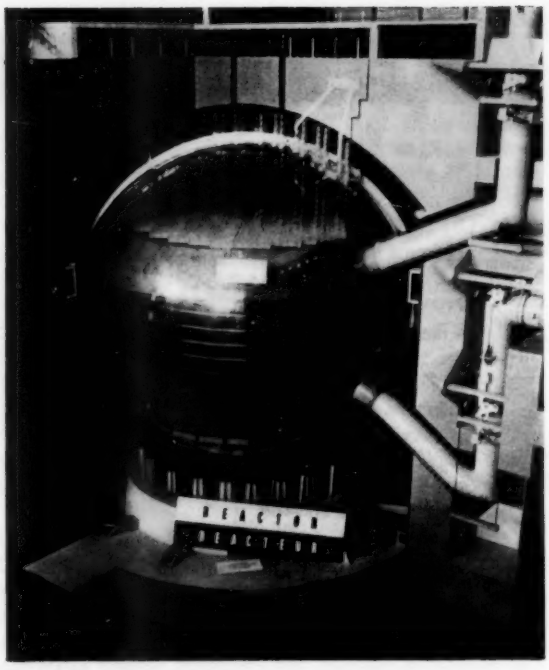
The synthetic 3-T cords are *2½ times stronger* than cotton. This means longer service at lower cost on any drive. The special design of the belt eliminates splice failure and ply separation. HD Endless Cord costs no more, yet you get much higher horsepower ratings, better service all round.

GOODYEAR
INDUSTRIAL RUBBER PRODUCTS

Transmission Belting
Conveyor Belting · Hose
V-Belts · Industrial Fenders

THE GOODYEAR TYRE & RUBBER COMPANY (GREAT BRITAIN) LIMITED, WOLVERHAMPTON

BRUSSELS GRAND PRIX.—An international jury chosen by the Commissioner General of the Belgian Government, awarded the Grand Prix for the best Precision Mechanics exhibit at the Universal and International Exhibition in Brussels to British Timken Limited (Chairman, Sir John Pascoe) manufacturers of tapered-roller bearings, Duston, Northampton. The Duke of Edinburgh is pictured visiting the prize winning stand in the British Industry Pavilion at the Exhibition. The stand, designed by L. Dorricott, manager of British Timken's publicity department, consists of a series of light oak showcases, into each of which are built colour transparencies, showing various applications of Timken bearings, together with internal and external views of the factory at Duston. Bearings on the stand range from a slowly revolving giant, weighing 3¼ tons, for a rolling mill, the largest bearing in the entire Fair, down to the smallest bearing weighing 1/1000 of an ounce, manufactured by the Fischer Bearings Company Limited, a subsidiary of British Timken. On the right is part



of the exhibit—a large perspex model of a nuclear power station—of The Nuclear Power Plant Company Limited of Knutsford, Cheshire for which the company was awarded the Supreme Grand Prix for exhibits concerned with the exploitation of nuclear energy. The picture shows the pressure vessel and control rods in the sectioned reactor building

Contracts and Work in Progress

THE GRESHAM TRANSFORMER GROUP.—Recent orders for the Middle East include one 68,000/480V transformer to Saudi Arabia and second successive contract for a further batch of transformers of several capacities up to 68,000V for the public supply of electricity to villages.

BRITISH INSULATED CALLENDER'S CABLES Limited.—Orders exceeding £500,000 in value from the National Telephone Company of Venezuela for the supply and installation of trunk and distribution telephone cables for the new Boleita exchange on the eastern outskirts of Caracas.

METALECTRIC FURNACES LIMITED, Smethwick.— Further orders from Italy for continuous annealing furnaces developed by the company.

METROPOLITAN-VICKERS ELECTRICAL Company Limited.—Order for flameproof battery locomotive from National Coal Board for Markham Colliery, near Chesterfield.

PYE TELECOMMUNICATIONS LIMITED.— Contract valued £80,000 from the Hong Kong Government for the supply of police radiotelephone equipment.

MERCURY TRUCK & TRACTOR COMPANY Limited, Gloucester.—Order for 40 Model 32P towing-tractors from the People's Republic of China.

JOHN THOMPSON WATER TUBE BOILERS Limited, Wolverhampton.—Share of £2¼M. contract for the building of Fuerzas Electricas de Cataluna S.A.'s new 60 MW power station at Mata, Barcelona, Spain. Main contractors are the B.T.H. Company Limited and the civil engineering contractors are Messrs. Balfour Beatty.

HEENAN & FROUDE LIMITED.—Further orders for air and water cooling equipment for the new slabbing and plate mills of the South Durham Iron & Steel Company Limited placed by Matthews & Yates Limited, Swinton.

E.M.I. ELECTRONICS LIMITED.—Contract for 1000 ft television aerial mast for the Independent Television Authority at Mendlesham, Suffolk.

Supply of digital computor Emidec 1100 to Glaxo Laboratories Limited.

AUTOMATIC TELEPHONE & ELECTRIC Company Limited.—Contract for the provision of switching equipment for public telephone exchanges to the East African Posts & Telecommunications Administration.

FOUNDRY EQUIPMENT LIMITED.—Contract for the supply of plant and equipment for new brass foundry for British Railways St. Rollox Works, Glasgow.

WILD-BARFIELD ELECTRIC FURNACES Limited.—Repeat order from Wellworthy Limited, Lymington, Hants., for a gas carburizing installation operating on the drip feed principle with Carbodrip.

THE POWER-GAS CORPORATION LIMITED, Stockton-on-Tees.—Order for a semi-water gas plant from Societe Iberica de Nitrogeno of Madrid for their Felguera Works.

LEYLAND MOTORS LIMITED.—Contract for the supply of 14 Super Hippo three-axled dump trucks for Hydro Electrica De Cavado through Leyland Portuguese agents, Francisco Garcia & Cia Ltda. of Lisbon.

PRESSED STEEL COMPANY.—Supply of 123 diesel multiple unit coaches for British Transport Commission.

Erratum

THE fourth line in the "Contracts and Work in Progress" column on page 478 of our October issue was accidentally transposed. It should have been the seventh line from the top.

Awards at the Brussels Exhibition

THE 87 firms exhibiting in the Birmingham Engineering Centre's collective exhibit in the British Industry Pavilion at the Brussels Exhibition gained a total of 28 awards. Amongst the firms sharing the collective awards were: The Morgan Crucible Company Limited (Equipment utilizing electric power; Ceramics); Saunders Valve Company Limited (Equipment for the chemical industry); Acheson Colloids Limited (Drawing out of wire and metals); Thomas Savery Pumps Limited (Motors and pneumatic and hydraulic machinery for general purposes); J. Neill & Co. (Sheffield) Limited (Industrial tools; precision mechanics).

Induction Heating-1

Electro-magnetic induction was discovered by Faraday and used by him to evolve the electric motor. In some cases, induction can be a nuisance by causing heat losses to arise from induced eddy currents in nearby pieces of metal, but in industry today those heat losses are being turned to good account as a method of metal heating.

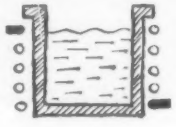
Induction heating produces heat only in the work piece. This is a fascinating and spectacular process which has the additional merit of being extremely effective. An important feature of induction heating is that it gives rapid temperature rise with no time lag, starting being instantaneous. Perhaps its greatest advantages are that it can be used in automatic processes and does not demand skilled labour.

Induction heating can deal efficiently with all the applications outlined below, and including metal melting, preheating and stress relieving, surface hardening, heating of large components, preheating of steel tubes for manipulating, heating for shrinking, for forging and extrusion, as well as for the heating of vessels. There are various methods of applying it, the method to be used being dictated by the application.

Technical details relating to the choice and use of individual types of induction heating will be set out in a subsequent data sheet.

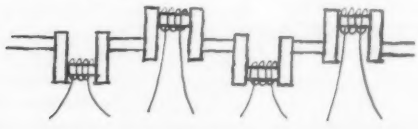
Metal melting

The oldest and largest application of induction heating lies in the melting of metals. The outstanding advantages are: freedom from deleterious gases and products of combustion and other contaminants, rapid speed of melting, low running costs, improved working conditions and reduced metal loss.



Metallurgical processes

This covers a large variety of processes which may be basically divided into surface heating and through heating. Most processes fall into the former category and are used for the purpose of



skin hardening. They include the treatment of such components as: pins, camshafts, crankshafts, rollers, cylinder liners, gear teeth, rocker arms and shafts and valve stems.

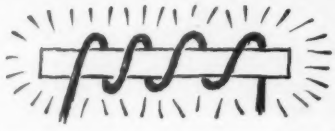
5857

Through Heating

When the current in an induction coil is maintained for a longer period it results in the heat engendered in the work piece penetrating to a greater depth and eventually throughout the piece. It is largely used for the heating of slugs and billets, for upsetting and upset forging, flanging and nosing, shearing and forging and bolt blanks for heading.

Annealing

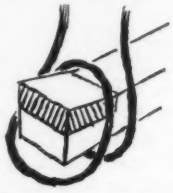
Induction heating is the ideal method of altering the character of metals for a special purpose. Annealing and its related process of tempering, normalising and stress relieving are prominent in



this category. In the case of annealing, one feature of the treatment is that it can be localised, while induction tempering can do in one minute what would require half-an-hour or more with conventional furnace heating.

Brazing, soldering and welding

Brazing and soldering by induction are the quickest and cleanest methods of joining metals together, and it is often beneficial to re-design the parts so that the fullest advantage can be taken of induction heating. Brazing can be used in the case of: carbide inserts for tools, tips for rock drills, parts for universal joints, etc., while the many applications of soldering are well-known. It was not until well into the present century that the age-old craft of welding became a positive aid to greater productivity. Induction welding produces a good, clean weld because oxidation is almost absent.



Miscellaneous Application

Induction heating can be profitably used for a large variety of purposes, including the fusion and hot pressing of powders, heating *in vacuo*, gas determination in metals, fusion of glass, chemical work and many other processes.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association.

Excellent reference books are available on electricity and productivity (8/6 each or 9/- post free)—"Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

Issued by the Electrical Development Association, 2 Savoy Hill, London, W.C.2.

Valves and Cocks

For over 125 years Robert Harlow and Son Limited, Stockport, Cheshire, have been making valves, cocks, boiler mountings and sundry fittings. Their latest catalogue —the fourth edition—gives details of over 3000 products, many of which the makers carry in stock. The catalogue is well produced and its contents are sectioned for easy reference, under various headings; stop and back pressure valves, safety valves, cocks and allied fittings, boiler mountings, etc.

Gas Tar Extraction

The removal of tar fog from manufactured gas is now almost exclusively accomplished by means of electrical detarrers which incur negligible pressure drops, low power inputs and require virtually no maintenance.

During the past quarter of a century W. C. Holmes & Company Limited, P.O. Box B7, Turnbridge, Huddersfield, have installed more than 325 electrical detarrers for cleaning all types of manufactured gas including, in particular, tar fog from oil gasification plants. Their latest designs are illustrated in a new leaflet, publication No. 74.

Electrolytic Conductivity Measurement

Electrolytic conductivity measuring cells for direct installation in the electrolyte flow line are fully described in a leaflet from Electronic Switchgear (London) Limited, 47 Victoria Street, Westminster, SW1. With annular, impervious carbon electrodes flush with the bore of the cell, the cells are simple to clean, by means of a bottle brush, and they do not restrict the through flow of liquid. The cell bodies, into which the electrodes are moulded, are of an inert plastic material that is resistant to attack by 10% solutions of sulphuric acid, hydrochloric acid and caustic soda. The cells are suitable for pressures and temperatures up to 150 psi and 80° C. respectively. The CCA series of cells are suitable for base exchange water softening plant, de-mineralized water plant, in research laboratories and for appraisal of soda ash content in sugar syrup, etc.

Tidal Power for Generating Stations

Where generating stations are sited on tidal estuaries great saving in the vast quantities of water required for condensing purposes can be made by resorting to self-acting penstocks and a tidal basin. In a new leaflet issued by the Ismailia Valve Company 17, Victoria Street, London SW1, details are given of schemes already in operation and the construction of the hingeless sluice gates employed.

Colloidal Graphite in the Glass Industry

A new Bulletin (No. 101) entitled " 'dag' colloidal graphite in the Glass Industry" issued by Acheson Colloids Limited, 18 Pall Mall, London SW1, outlines the uses and advantages of "dag" products as lubricants and parting agents for glass moulds and other equipment used in glass bottle manufacture. Among the subjects covered are automatic spray application, tool and mould pre-treatment and the lubrication of chutes and belt conveyors. Copies of the folder may be obtained from Acheson Colloids Limited, P.O. Box No. 12, Plymouth, Devon.

Corrosion Resistance of Titanium

The exceptional high strength/weight ratio of titanium has led to its rapid development for use in the aircraft industry. Perhaps not so widely appreciated is its excellent resistance to many highly corrosive environments, notably sea water, nitric, chromic and acetic acids. Resistance to many mineral acids can be increased by the addition of suitable acid salts or oxidizing acids.

The results of laboratory tests on commercially pure titanium (Jessop Hylite 10 and 15) subjected to mineral acids, inorganic salts, organic compounds, gases, etc., are contained in information sheet No. M811 issued by William Jessop and Sons Limited, Brightside Works, Sheffield 9.

Trade Literature

Air Control Valves

A new series of pneumatic control valves is announced by Martonair Limited Parkshot, Richmond, Surrey, who have issued descriptive leaflets and price lists.

The valves, which are suitable for heavy duty in all industries, are made in both three-port and five-port form, in ¼ in. ⅜ in. and 1 in. B.S.P. sizes. The four operating mechanisms—single pressure with air return, double pressure, lever with air return and three-position lever—are interchangeable between themselves and between different sizes of body.

V-Belt Drive Manual

The new issue of the GraKnight V-Belt drive manual, now in its fifth edition, contains increased horsepower tables for the GraKnight Raycord V-Belt and many additional sizes to their list of standard V-Belts.

Details of the Bushlok V-pulley with twin taper locking bushes are included for the first time.

Copies are available free of charge from the makers Graton & Knight Limited, Warwick Road, Boreham Wood, Herts.

Claw-type Cable Cleating

The claw-type cable cleating system developed by British Insulated Callender's Cables Limited, 21 Bloomsbury Street, London WC1, is explained in a new BICC publication No. 287B. A comprehensive range of cleats suitable for all types of cable sheathed with lead or aluminium are illustrated and recommendations for fixing are given.

Photo-switch Range

Data Sheet PR Issue 1 issued by Elcontrol Limited, Wilbury Way, Hitchin, Herts. shows the principal features of their latest range of photorelays, viewing heads and light sources. An aid to installation and servicing is the style of construction adopted for the relay unit which embodies an unpluggable chassis mounted in a cradle which is, in turn, secured to the lower half of the case.

The size of the viewing head and light source has been considerably reduced to enable photoelectric control to be applied to complex machinery.

New Aerofoil Fan Catalogue

Additions to the Aerofoil fan range covered in a new edition of the Woods of Colchester catalogue V1089 include a new 60-in. size and the introduction of 12-in. fans in the adjustable pitch impeller series, eight diameters being now available. Amongst new ancillary equipment is an attachable guide vane unit giving up to 15% higher pressure without increase in horsepower. Woods silencers have been redesigned to permit hot dip galvanized finish and lower prices.

For convenience in use the new catalogue is in two sections, descriptions and illustrations are contained in one part, reference V1089, and fan selection tables, dimensions and weights in a separate section, V1089T. Fans are quoted for over 1300 volume/pressure combinations up to 75,000 cfm and 20 swg. Copies of the catalogue can be obtained from Woods of Colchester Limited, Braiswick Works, Colchester.

Press Brake Tool Manual

Mention has already been made in our Technique pages this month to the Bronx press brake tool manual. This excellent publication which is profusely illustrated and indexed deals with the subject in manner commendable to new and experienced designers and operators. The contents include recommendations, loads and allowances for bending all material and a multitude of tool set-ups for simple bends, channels, box and tray forming, hemming, offset and joggling and tube and bead forming. Other subjects include gauging, punching and notching and methods of tool changing on Bronx press brakes. Copies are available from Bronx Engineering Company Limited, Lye, Worcs.

Accessories for Turret Punch Presses

Useful accessories for the British Wiedemann turret punch presses are shown in the latest catalogue from Dowding & Doll Limited, 346, Kensington High Street, London W14. The attachments include a double jaw work holder, minus dimensioning equipment and a template punching tool unit.

PROBLEMS?

we welcome them

A mobile 50 gallon oil dispenser for rapid and metered sump filling.

A high pressure dispenser capable of being wheeled over uneven surfaces.

This era of increasing productivity has brought with it entirely new engineering techniques and developments. It has presented the lubrication engineer with a whole series of new problems. One of these units may solve your particular problem. If not, we can produce a special lubricator for you. Why not write for one of our specialists to call and discuss your lubrication difficulties. Let us shoulder your worries. We thrive on them.

A 9 gallon pressure unit for spraying detergent mixtures to the undersides of vehicles for the removal of encrusted dirt and grease.

A positive solution for the pumping of heavy and non self-levelling greases.

WAKEFIELD
LUBREQUIPMENT
REG.

C. C. Wakefield & Co., Ltd. · 46 Grosvenor St. · London · W.1

Berwick. Jus-Rol, Limited, 50 Duke Street, Coldstream, are to erect a pastry factory on Tweedside trading estate.

Blaydon (Co. Durham). W. D. Mark and Son, Lawrence Street, York. The U.D.C. has approved plans for frozen food store, and offices. The architects are Glover Partners, Frances Street, London, SW1.

Carlisle. T. Wall and Sons, Limited. An ice cream storage and distribution depot is to be built on the Durranhill industrial estate. The architects are Thompson, Broadbent and Wilson, Hillary Place, Leeds.

Felling (Co. Durham). International Paints, Limited, are to extend their offices by about 8,000 sq ft in Stoneygate Lane, and have prepared their own plans.

Gateshead. Metropole Motors (Glasgow), Limited, Stockwell Street, Glasgow, propose showrooms, etc., in High Street, Gateshead. The firm's architect is R. Bluck, 147 Bath Street, Glasgow, C.2.

Hartlepool. Richardson, Westgarth & Co. Limited, electrical plant manufacturers, etc., are to carry out extensions to their offices. Plans are by L. J. Couves and Partners, Grainger Chambers, Hood Street, Newcastle upon Tyne.

Houghton-le-Spring. Bursgreen (Durham), Limited, woodworking machinists. The Urban District Council has approved plans for a warehouse of about 5,000 sq. ft. Architects, Mauchlen, Weightman and Elphick, Saville Row, Newcastle upon Tyne.

Middlesbrough. G. Crolla. Ice cream factory in Jefferson Street. T. A. Crawford, 80 Borough Road, Middlesbrough, is the architect.

L. Lyons & Co. Limited, London. To erect storage and distribution depot at Cargo Fleet Lane. The architect is R. H. Sykes, 141 Hammersmith Road, London, W14.

Munro and Miller, Limited, pipework engineers, Windermere Road, Middlesbrough. To erect office block, plant and repair depot.

W. Shaw & Co. Limited. Plans are to be prepared for rebuilding work at Acklam Foundry.

The General Electric Company Limited, London are negotiating for 7,500 sq yds of land in Longlands Road for offices and stores.

Newcastle upon Tyne. Swan Hunter and Wigham Richardson, Limited. A new building berth, where ships 550 ft long can be built, is to be constructed at the Walker Shipyard. The consulting engineers are T. F. Burns and Partners, 3 Ellison Place, Newcastle.

South Shields. The CWS Limited, plan soft drinks distributing depot at Maxwell Street. The Society's architects' dept., is at 90 Westmorland Road, Newcastle upon Tyne.

Stockton-on-Tees. James Walker & Co., Woking, Surrey, propose offices and warehouse on North Tees industrial site for the storage and sale of hydraulic packings and jointings.

Sunderland. G. Marshall and Son. Plans for a copper shop at North Quay have been prepared by G. T. Brown and Son, 53 Fawcett Street.

Whickham. Ellis (Metals), Limited, 30 Great North Road, Newcastle upon Tyne are to erect office block to plans by Mauchlen, Weightman and Elphick' Saville Row, Newcastle upon Tyne.

Alloa. Donaldson Textiles Limited, Hall Park Mills, are to make extensions to their works.

Belfast. Coseley Buildings (Northern Ireland) Limited, 36 Victoria Square, are to build a new factory at Carnmoney.

Birkenhead. Moorhouse Brothers, Limited, 55 Everton Road, Anfield, Liverpool. The architect for the erection of a mineral water factory is F. H. Frost, 73 Oxton Road.

Birmingham. Larcher Cutters Limited, Regan Place, are to build a new factory at Moor Lane, Witton.

Holt Chromium Plating Company Limited, 24 Legge Street, Aston Cross. A new factory is to be built in Blews Street, Aston.

Blackpool. Blackpool Rope & Twine Company Limited. A new factory and offices to be built in Clifton Road.

New Factories

Bolton. J. W. Marshall & Co. Limited. Extensions are to be made to Springfield Paper Mills, Bradford Street.

Brighton. New Welbeck Limited, Moulscomb Way are to build a new factory at Westergate Road.

C. B. R. Jersey Mills Limited. Extensions are to be made to the works in Shanklin Road.

Cheadle Hulme. The Reddish Chemical Company Limited, Globe Works, Gorton Road, Reddish, are to build a new factory and offices on Stanley Road Industrial Estate.

Chester. Tizer Limited, Pretoria Road, Edmonton, London, N18, are to erect a new factory at Sealand trading estate.

Cork. Irish Steel Holdings, Haulbowline, are considering making extensions to their works.

Coventry. F. M. T. Engineering Company Limited, Bedlum Lane works are to be extended.

Croydon. D. J. Osborne & Co. Limited. Extensions are to be made to the factory in Canterbury Road.

A. Warner & Sons, Limited, are to extend their factory in Vulcan Way.

Dagenham. Ford Motor Company Limited, are to build a new forge shop.

Dundee. Denison Engineering Division of the American Brake Shoe Company, Columbus, Ohio. A new factory is to be built by Scottish Industrial Estates, Limited, 3 Woodside Place, Glasgow.

Edmonton. Sparklets Limited, Queen Street, London, N17. Extensions are to be made to the factory.

Hereford. H. & R. Johnson (Hereford) Limited. Extensions are to be made to the factory at Barrs Court Road.

High Wycombe. Stephens & Carter Limited. The architects for extensions to the factory in Coronation Road are Brocklehurst, Cooper & Williamson, 39a High Street.

Hounslow. Perrett Control Company Limited, 237 Acton Lane, Chiswick. A new factory is to be erected at Green Lane. The architects are Huckle & Durkin, 30 Queen Anne Street, Cavendish Square, London, W1.

Kinsale. Eire. Kinsale Canners Limited. The architect for the new fish canning factory is Frank Murphy, 44 South Mall, Cork.

Leamington Spa. Ludwell & Co. Limited, are to make extensions to their factory at Queensway trading estate.

Luton. Charles Bird & Sons, Limited. A new factory and offices to be built at 112 Collingdon Street.

Manchester. J. Mountford & Co. Limited Colliery Street, Clayton, are to make extensions to their Clayton Forge. The architect is Raymond Jay, 15 Oldham Road, Rochdale.

Mansfield. Foister, Clay & Ward Limited, Redcliffe Road. Extensions are to be made to the works.

Mansfield Hosiery Mills Limited, Botany Avenue. Factory extensions.

Newbury. Boreham's Car Electrical Service, Limited's West Mills are to be extended.

Plymouth. Smith's Potato Crisps Limited, Manor Street. The architects for the new factory are J. Stanley Beard, Bennett & Wilkins, 101 Baker Street, London, W1.

Sedgeley. Tube Fittings Manufacturing Company Limited, Upper Ettingshall Road, Coseley, are seeking a site for a new factory.

Southend-on-Sea. V. C. Bond & Sons, Limited, Progress Way, Eastwood. Contractors for works extensions are C. S. Foster & Sons, Limited, Loughton.

Stalybridge. Futura Rubber Company, Quarry Street Mill. Factory extensions.

Sudbury. E. R. Holloway Limited, 17 Bessemer Road, Welwyn are to erect a new factory on the Sudbury-Cambridge Road at Glemsford.

Surbiton. W. Platt & Sons Limited, Davis Road, Chessington. Works extension.

Tipton. Newey Brothers, Limited, Sedgeley Road West. Factory extensions. The contractors are C. Bryant & Sons, Limited, 65 Whitmore Road, Birmingham.

Edinburgh. Edinburgh Corporation are to proceed with a programme of modernizing and mechanizing public wash houses in the city. The first scheme has been approved for Lochrin where £5000 is being spent on mechanical washing plant and ancillary equipment.

Glasgow. Strathclyde and Long John Distillers Limited, are to build a new gin production building at 1780 London Road, Glasgow.

Gemmell's Dairies Limited are erecting cold storage space and loading facilities at 41/59 Tylefield Street, Glasgow, E1.

The Scottish Co-operative Society Limited are building additional grain storage silos at Bunhouse Road.

Greenock. International Business Machines Limited are to add about half their existing space at the Spango Valley to meet growing production. The new block will be built by Scottish Industrial Estates Limited and cost £231,000. It will be completed by the end of 1959 and will measure 334 ft long by 140 ft wide.

Leith. Ralph Symonds (Scotland) Limited are to go ahead with the construction of an £80,000 prototype factory to build laminated timber structures. Completion is expected next year.

Montrose. J. and G. Paton Limited, Chapel Works, are to alter premises in Paton's Lane for use as a bottling plant and warehouse. Approval has been given by the Dean of Guild Court.

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Further particulars and application forms are obtainable from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. or from the Registrar, University of Queensland, Brisbane, Queensland, Australia.

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Patents for Sale or License

THE proprietor of British Patent No. 732322, entitled "Jogging Machine", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietors of Patent No. 732327 for "Improvements in or relating to Valve Operating Mechanism" desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co. 28, Southampton Buildings, Chancery Lane, London, W.C.2.

THE proprietor of British Patent No. 628345, entitled "Combined impeller and closure", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 711112, entitled "Improvements relating to the condition of the exhaust gases of internal combustion engines" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 733734, entitled "Turning and Boring Machines", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

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